Errata and Clarifications (September 2020)

1) On page 18, the radial line from the origin to point P should be labeled "r" rather than "ρ".

2) On page 19, the last of the three equations of Eq. 1.14 should say $\hat{z} = \hat{k}$.

3) On page 24 in the second line of Problem 1.9, the word "spherical" should be replaced by the word "cylindrical". Hence the phrase should be "...a steady current I is given in cylindrical coordinates by the expression...."

4) On the top of page 35 in the second line of the right-hand side of the equation for $\vec{A} \times (\vec{B} \times \vec{C})$, the term $A_x C_y$ should be $A_x C_x$.

5) On the top of page 48 in the right-hand side of the equation for $\vec{\nabla} \circ \vec{A}$, there should be no vector symbols over the components A_x, A_y, and A_z.

6) On page 57, the paragraph beginning with "And how does the difference..." should read "And how does the difference between a function's value at a point and the average value at neighboring points relate to the divergence of the gradient of that function? To understand that, think about a point which is a local maximum of the function - at such at point, the function's value is greater than the surrounding average. Likewise, at a point which is a local minimum, the function's value is less than the surrounding average. This is the reason you may find the Laplacian described as a "concavity detector" - it finds points at which the value of the function sticks above or falls below the average value of the surrounding points."

7) On page 60 in Problem 2.3, in two places vertical-line symbols are printed as slanting lines (this occurs after the letter "B", once before "cos" and once before "sin"). Here is the correct text:

2.3 Show that $\vec{A} \circ \vec{B} = A_x B_x + A_y B_y + A_z B_z = |\vec{A}||\vec{B}| \cos(\theta)$ and that $|\vec{A} \times \vec{B}| = |\vec{A}||\vec{B}| \sin(\theta)$.

8) On page 68, the sentence beginning "According to this equation..." should say that the y-component of the box's acceleration is proportional to (rather than equal to) the difference between the magnitude of the normal force and the y-component of the gravitational force.

9) On page 71, 77, and 80 the word "accelerate" is misspelled.

10) On page 87, the units of the permittivity of free space should be $\mathrm{C}^2/(\mathrm{Nm}^2)$.

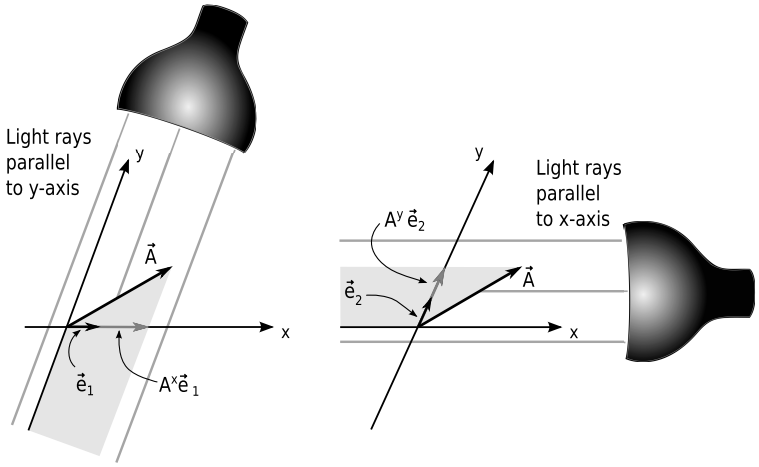
11) On page 88, the equation on the second line should contain the term $\left(\frac{k_e q}{r^2}\right)$

rather than $\left(\frac{k_e q}{r}\right)$.

12) On page 90, the equation for the divergence of the magnetic field near the bottom of the page (after Eq. 3.36) should read

$$\vec{\nabla} \circ \vec{B} = \frac{1}{r}\frac{\partial B_\phi}{\partial \phi} = \frac{1}{r}\frac{\partial}{\partial \phi}\left(\frac{\mu_0 I}{2\pi r}\right)$$

13) On page 114 in the right portion of Figure 4.13, the basis vector along the y axis labeled $\vec{e}^{\,2}$ should be $\vec{e}_2$. Here's a corrected version of the figure:



14) Clarification: On page 126, the paragraph beginning with "And here's the important insight..." should make it clear that the columns of the transformation matrix are the components of the basis vectors.

15) On the bottom of page 129 in the right side of Equation 4.62, A_i should be A_j.

16) In the statement for Problem 4.1 on page 130, the word "indirect" should be "direct."

17) In the statements for Problems 4.6 and 4.8 on page 130, the vector components A^1, A^2, A_1 and A_2 should not have vector arrows.

18) On pages 133 to 136, in Equations 5.1 through 5.9 and the text in-between, the prime marks should appear before the superscripts. So on these pages, $\partial x^{i'}$

should be $\partial x'^i$.

19) On page 134, the statement beginning with "And just as in Equation 5.1..." should read "And just as in Equation 5.1, the elements of the inverse transformation matrix also represent the basis vectors tangent to the original coordinate axes."

20) On page 135, the statement beginning with "In this case, the weighting factors..." should read "In this case, the weighting factors ($\frac{\partial x^j}{\partial x'^i}$) are the elements of the direct transformation matrix from the unprimed to the primed coordinate systems..."

21) On page 140, in the sentence "...or using covariant components and dual basis vectors ($\vec{e}_i$)..." the subscript 'i' should be a superscript. So the corrected sentence reads "...or using covariant components and dual basis vectors ($\vec{e}^{\,i}$)...".

22) On page 141, the final equation in the second block of equations (after the sentence "A third option is to use contravariant components on one side of the dot and covariant components on the other:") should say $= dx^i dx_i$.

23) On the top of page 142 in the second line of the equation for $|\vec{A}|$, the expression $\sqrt{A^i A_j}$ should be $\sqrt{A^i A_i}$.

24) On the bottom of page 142 and top of page 143, the expression for the square of the differential length element (ds^2) is correct for any orthonormal coordinate system (that is, any coordinate system for which the dot product of the basis vectors $\vec{\epsilon}_i \circ \vec{\epsilon}_j = \delta_{ij}$). However, for the general case (including non-orthonormal coordinate systems), the expression for ds^2 should be

$$ds^2 = \left[\left(\frac{\partial x'^i}{\partial x^1}dx^1 + \frac{\partial x'^i}{\partial x^2}dx^2 + \frac{\partial x'^i}{\partial x^3}dx^3\right)\left(\frac{\partial x'^j}{\partial x^1}dx^1 + \frac{\partial x'^j}{\partial x^2}dx^2 + \frac{\partial x'^j}{\partial x^3}dx^3\right)\right]\left(\vec{\epsilon}_i' \circ \vec{\epsilon}_j'\right)$$

which reduces to Eq. (5.12) for orthonormal systems. Likewise, the expressions for the elements of g on page 143 are correct for the orthonormal case, but in the general case, the elements of g should include the cross terms shown in Eq. 5.15 as revised below.

25) On page 144, for the general case (including non-orthonormal coordinate systems), Eq. 5.15 should be

$$\begin{aligned} g_{ij} = &\left[\left(\frac{\partial x'^1}{\partial x^i}\frac{\partial x'^1}{\partial x^j}\right)\left(\vec{\epsilon}_1' \circ \vec{\epsilon}_1'\right) + \left(\frac{\partial x'^2}{\partial x^i}\frac{\partial x'^2}{\partial x^j}\right)\left(\vec{\epsilon}_2' \circ \vec{\epsilon}_2'\right) + \left(\frac{\partial x'^3}{\partial x^i}\frac{\partial x'^3}{\partial x^j}\right)\left(\vec{\epsilon}_3' \circ \vec{\epsilon}_3'\right)\right] \\ &+ 2\left[\left(\frac{\partial x'^1}{\partial x^i}\frac{\partial x'^2}{\partial x^j}\right)\left(\vec{\epsilon}_1' \circ \vec{\epsilon}_2'\right) + \left(\frac{\partial x'^1}{\partial x^i}\frac{\partial x'^3}{\partial x^j}\right)\left(\vec{\epsilon}_1' \circ \vec{\epsilon}_3'\right) + \left(\frac{\partial x'^2}{\partial x^i}\frac{\partial x'^3}{\partial x^j}\right)\left(\vec{\epsilon}_2' \circ \vec{\epsilon}_3'\right)\right] \end{aligned}$$

26) On page 148, in the final equation on the page, the subscript 1 in the basis vector $\vec{e}_1$ should be an i. So the corrected equation is

$$\begin{aligned}\frac{\partial \vec{A}}{\partial x^1} &= \frac{\partial (A^1\vec{e_1} + A^2\vec{e_2} + A^3\vec{e_3})}{\partial x^1} \\ &= \frac{\partial (A^i\vec{e_i})}{\partial x^1} \\ &= \frac{\partial A^i}{\partial x^1}\vec{e_i} + A^i\frac{\partial \vec{e_i}}{\partial x^1}\end{aligned}$$

27) On page 149, in the fourth line from the top of the page, the word "differentiation" is misspelled as "defferentiation".

28) On page 151, the word "of" is missing from the sentence beginning "Now it's just a matter of pulling out..."

29) On page 153, in the expression for Γ^1_{22}, the multiplying factor for the third term should be $\frac{1}{2}g^{31}$.

30) On page 155 in the expression for $A^{\phi}_{;\phi}$ on the right side of the equation the second term should contain A^r instead of $A^{\phi}$and the third term should contain A^{ϕ} instead of A^r. The correct equation is:

$$\begin{aligned}A^{\phi}_{;\phi} &= \frac{\partial A^{\phi}}{\partial \phi} + A^r\Gamma^{\phi}_{r\phi} + A^{\phi}\Gamma^{\phi}_{\phi\phi} + A^z\Gamma^{\phi}_{z\phi} \\ &= \frac{\partial A^{\phi}}{\partial \phi} + A^r\left(\frac{1}{r}\right) + 0 + 0\end{aligned}$$

31) On page 155, the final equation should be

$$\frac{\partial \vec{A}}{\partial \phi} = (\frac{\partial A^r}{\partial \phi} - rA^{\phi})\vec{e}_r + (\frac{\partial A^{\phi}}{\partial \phi} + \frac{1}{r}A^r)\vec{e}_{\phi} + \frac{\partial A^z}{\partial \phi}\vec{e}_z$$

32) On the bottom of page 169 and on the following two pages, the rotation about the y-axis is a CLOCKWISE rotation through angle θ_2.

33) On page 170, Equation 6.8 (and the corresponding matrices on page 171) should be

$$\begin{pmatrix} x' \\ y' \\ z' \end{pmatrix} = \begin{pmatrix} 0.866 & -0.25 & 0.433 \\ 0 & 0.866 & 0.5 \\ -0.5 & -0.433 & 0.75 \end{pmatrix} \begin{pmatrix} x \\ y \\ z \end{pmatrix}$$

and Equation 6.9 (and the corresponding matrix on page 171) should be

$$\vec{\vec{I}} = \begin{pmatrix} 17.8ma^2 & -2.6ma^2 & -3.9ma^2 \\ -2.6ma^2 & 17ma^2 & -4.5ma^2 \\ -3.9ma^2 & -4.5ma^2 & 13.3ma^2 \end{pmatrix} \tag{1}$$

34) On page 176, in the expression for the square of the distance covered by a wavefront of the light wave in the unprimed coordinate system, the right side should be $(ct)^2$ (that is, $x^2 + y^2 + z^2 = (ct)^2$), and in the primed coordinate system, the right side should be $(c't')^2$ (that is, $x'^2 + y'^2 + z'^2 = (c't')^2$). Hence the equation at the top of this page should be

$$(ct)^2 - x^2 - y^2 - z^2 = (ct')^2 - x'^2 - y'^2 - z'^2$$

since the speed of light is the same for all observers ($c = c'$).

35) On page 182 in the matrix at the top of the page, at the bottom row of the second column, the expression $(B_y)(-\gamma)$ should be $(-B_y)(\gamma)$, and in the expression for $\vec{F}'$, the element in the third column of the first row should be $-\gamma(E_y/c - \beta B_z)$.

36) On page 183 near the end of the second paragraph, the second-last sentence should ask"So does the electric field exist or not?"

37) On page 190, in the expression

$$\Gamma^{\theta}_{\phi\phi} = (\frac{1}{2}) - g^{\theta\theta}\frac{\partial g_{\phi\phi}}{\partial\theta}$$

the minus sign should be in front of the (1/2) factor. So the correct expression is

$$\Gamma^{\theta}_{\phi\phi} = -(\frac{1}{2})g^{\theta\theta}\frac{\partial g_{\phi\phi}}{\partial\theta}$$

38) On page 191, in the second equation from the top, which is

$$R^{\theta}{}_{\phi\theta\theta} = \frac{\partial\Gamma^{\theta}_{\phi\theta}}{\partial\theta} - \frac{\partial\Gamma^{\theta}_{\phi\theta}}{\partial\phi} + \Gamma^{\theta}_{\phi\theta}\Gamma^{\theta}_{\theta\theta} + \Gamma^{\phi}_{\phi\theta}\Gamma^{\theta}_{\phi\theta} - \Gamma^{\theta}_{\phi\theta}\Gamma^{\theta}_{\theta\theta} - \Gamma^{\phi}_{\phi\theta}\Gamma^{\theta}_{\phi\theta}$$

the second term after the equals sign should have θ instead of ϕ in the denominator. The correct expression is

$$R^{\theta}{}_{\phi\theta\theta} = \frac{\partial\Gamma^{\theta}_{\phi\theta}}{\partial\theta} - \frac{\partial\Gamma^{\theta}_{\phi\theta}}{\partial\theta} + \Gamma^{\theta}_{\phi\theta}\Gamma^{\theta}_{\theta\theta} + \Gamma^{\phi}_{\phi\theta}\Gamma^{\theta}_{\phi\theta} - \Gamma^{\theta}_{\phi\theta}\Gamma^{\theta}_{\theta\theta} - \Gamma^{\phi}_{\phi\theta}\Gamma^{\theta}_{\phi\theta}$$

39) On page 192, in the expression for $R^{\phi}{}_{\theta\phi\phi}$, the first Christoffel symbol in the fifth term should be $-\Gamma^{\theta}_{\theta\phi}$, so the entire expression should be

$$R^{\phi}{}_{\theta\phi\phi} = \frac{\partial \Gamma^{\phi}_{\theta\phi}}{\partial \phi} - \frac{\partial \Gamma^{\phi}_{\theta\phi}}{\partial \phi} + \Gamma^{\theta}_{\theta\phi}\Gamma^{\phi}_{\theta\phi} + \Gamma^{\phi}_{\theta\phi}\Gamma^{\phi}_{\phi\phi} - \Gamma^{\theta}_{\theta\phi}\Gamma^{\phi}_{\theta\phi} - \Gamma^{\phi}_{\theta\phi}\Gamma^{\phi}_{\phi\phi}$$

40) On page 193, the statement for Problem 6.3 should say"Find the moment of inertia tensor for the arrangement of masses in Problem 6.1...."