Correction to: Introduction to Partial Differential Equations

Peter J. Olver

Correction to:
P. J. Olver, *Introduction to Partial Differential Equations,* Undergraduate Texts in Mathematics, https://doi.org/10.1007/978-3-319-02099-0

After the second printing of the book in 2016, several errors were identified that needed correction. The following corrections have been updated within the current version, along with all known typographical errors.

Page xix: *Change* Corrected Printing *to* First Corrected Printing (2016)
Then add

Second Corrected Printing (2020)

Further corrections and improvements to the exposition have been incorporated into this new printing. I would particularly like to thank Lawrence Baker for his detailed reading of both the full text and the Solutions Manual, and thereby spotting many of the required corrections in both. I would also like to thank Henry Boateng, Joseph Feneuil, Adam Kay, Manuel Mañas, Svitlana Mayboroda, Bruno Poggi, Ma Shi-Zhuang, Radu Slobodeanu, James Stowe, and John Zweck for their suggestions and corrections. Finally, I thank Loretta Bartolini at Springer for all her help navigating the production process.

Also change May 2016 *to* July, 2020

Page 5: *Lines 8–10: change sentence beginning* "In general, the *domain* … " *to*
In general, the *domain* D will be an open subset, usually connected, and hence *path-wise connected*, meaning any two points can be connected by a curve $C \subset D$, and, particularly in equilibrium equations, often bounded, with a reasonably nice boundary, denoted by ∂D.

Page 8: *In exercise 1.10*(a) *change* $4t^2 - x^2$ *to* $4t^2 + x^2$.

The updated online version of the book can be found at
https://doi.org/10.1007/978-3-319-02099-0

P. J. Olver, *Introduction to Partial Differential Equations,* Undergraduate Texts in Mathematics,
https://doi.org/10.1007/978-3-319-02099-0_13

Page 21: *On line 4 below figure, change* "… counting principle of Chapter 1, …" *to* "… counting principle formulated on page 6, …"

Page 30: *Revise Exercise 2.2.19:*
2.2.19.(a) Find and graph the characteristic curves for the equation $u_t + (\sin x)\, u_x = 0$. Suppose you are given initial data (*i*) $u(0,x) = \left|\cos \frac{1}{2} x\right|$, (*ii*) $u(0,x) = \cos \frac{1}{2}\pi x$. (*b*) Write down a formula for the solution. (*c*) Graph your solution at times $t = 0, 1, 2, 3, 5$, and 10. (*d*) What is the limiting solution profile as $t \to \infty$?

Page 57: *In the last two displayed formulas, the first term on the right hand side of the equals sign is missing a minus sign:*

$$\frac{\partial v}{\partial \xi}(\xi,\eta) = -\frac{1}{2c}\frac{\partial u}{\partial t}\left(\frac{\eta-\xi}{2c}, \frac{\eta+\xi}{2}\right) + \frac{1}{2}\frac{\partial u}{\partial x}\left(\frac{\eta-\xi}{2c}, \frac{\eta+\xi}{2}\right),$$

and so, in particular,

$$\frac{\partial v}{\partial \xi}(\xi,\xi) = -\frac{1}{2c}\frac{\partial u}{\partial t}(0,\xi) + \frac{1}{2}\frac{\partial u}{\partial x}(0,\xi) = 0,$$

Page 61: *Revise Exercise 2.4.12:*
2.4.12. Given a classical solution $u(t,x)$ of the wave equation, let $E = \frac{1}{2}(u_t^2 + c^2 u_x^2)$ be the associated *energy density* and $P = u_t u_x$ the *momentum density.* (a) Prove that $\partial P/\partial t = \partial E/\partial x$ and $\partial E/\partial t = c^2 \partial P/\partial x$. Explain why both E and P are conserved densities for the wave equation. (*b*) Show that $E(t,x)$ and $P(t,x)$ both satisfy the wave equation. (*c*) Suppose that both $u_t(t,x) \to 0$ and $u_x(t,x) \to 0$ as $|\,x\,| \to \infty$ sufficiently rapidly in order that the integrals defining the *total momentum* $\mathcal{P}(t) = \int_{-\infty}^{\infty} P(t,x)\,dx$ and the *total energy* $\mathcal{E}(t) = \int_{-\infty}^{\infty} E(t,x)\,dx$ are defined and finite for each $t \in \mathbb{R}$. Show that $\mathcal{P}(t)$ and $\mathcal{E}(t)$ are conserved quantities, i.e., they are constants, independent of the time t.

Page 88: *Revise Exercise 3.2.47:*
3.2.47. (a) Graph the partial sums $s_3(x), s_5(x), s_{10}(x)$ of the Fourier series (3.55). Do you notice a Gibbs phenomenon? If so, what is the amount of overshoot? If not, explain why. (*b*) Answer the same question for the Fourier series (3.81) for the function $\operatorname{sign} x$.

Page 91: *Change page header to* 3.2 Fourier Series

Page 131: *In (4.37), change final + to −:*

$$u(t,x) \approx \tfrac{1}{2} a_0 + e^{-t}(a_1 \cos x + b_1 \sin x) = \tfrac{1}{2} a_0 + r_1 e^{-t} \cos(x - \delta_1), \tag{4.37}$$

Page 152: *On line -6, change* "… appear the context of boundary …" *to* "… appear in the context of boundary …"

Page 163: *On the last line of table, change* $x^4 - 4x^2y^2 + y^4$ *to* $x^4 - 6x^2y^2 + y^4$

Page 168: *On line 11, change* "… easy consequence of Green's Theorem, … " *to* "… easy consequence of Green's Theorem 6.13, … "

Page 188: *In example 5.4, change the sentence after the displayed formula to*
used earlier in Example 4.1, along with homogeneous Dirichlet boundary conditions, so $u(t,0) = u(t,1) = 0$.

Page 190: *In equation (5.28), change* $\mathrm{O}\big((\Delta t)^2\big)$ *to* $\mathrm{O}(\Delta t)$:

$$\frac{\partial u}{\partial t}(t_j, x_m) \approx \frac{u(t_j, x_m) - u(t_{j-1}, x_m)}{\Delta t} + \mathrm{O}(\Delta t). \tag{5.28}$$

Page 195:: *Change sentence after equation (5.40):*
We work on the interval $0 \le x \le 1$, and use step sizes $\Delta t = \Delta x = .005$. Let us try four different values of the wave speed.

Page 198: *In equation (5.45), change the denominator to* $2\,\Delta x$:

$$\frac{\partial u}{\partial x}(t_j, x_m) \approx \frac{u_{j,m+1} - u_{j,m-1}}{2\,\Delta x} + \mathrm{O}\big((\Delta x)^2\big). \tag{5.45}$$

Page 210: *Correct last displayed equation by switching indices on the* $u_{i,j}$:

$$\begin{aligned} u_{1,1} &= .1831, & u_{2,1} &= .2589, & u_{3,1} &= .1831,\\ u_{1,2} &= .3643, & u_{2,2} &= .5152, & u_{3,2} &= .3643,\\ u_{1,3} &= .5409, & u_{2,3} &= .7649, & u_{3,3} &= .5409, \end{aligned}$$

Page 211: *In equation (5.78), the sub- and super-diagonal matrix elements should be* -1, *not* $-\rho^2$:

$$B_\rho = \begin{pmatrix} 2(1+\rho^2) & -1 & & & & & \\ -1 & 2(1+\rho^2) & -1 & & & & \\ & -1 & 2(1+\rho^2) & -1 & & & \\ & & -1 & 2(1+\rho^2) & -1 & & \\ & & & \ddots & \ddots & \ddots & \\ & & & & -1 & 2(1+\rho^2) & -1 \\ & & & & & -1 & 2(1+\rho^2) \end{pmatrix} \tag{5.78}$$

Page 212: *In equation (5.82), replace* $\mathbf{w}^{(n-1)}$ *by* $U_{n-1}\mathbf{w}^{(n-1)}$ *and* U_j *by* U_k:

$$\begin{aligned} \mathbf{z}^{(1)} &= \widehat{\mathbf{f}}^{(1)}, & \mathbf{z}^{(j+1)} &= \widehat{\mathbf{f}}^{(j+1)} - L_j\mathbf{z}^{(j)}, & j &= 1, 2, \dots, n-2,\\ U_{n-1}\mathbf{w}^{(n-1)} &= \mathbf{z}^{(n-1)}, & U_k\mathbf{w}^{(k)} &= \mathbf{z}^{(k)} - \rho^2\,\mathbf{w}^{(k+1)}, & k &= n-2, n-3, \dots, 1, \end{aligned} \tag{5.82}$$

In equation (5.83), replace L_j *by* L_k:

$$\mathbf{w}^{(k)} = L_k\big(\mathbf{w}^{(k+1)} - \rho^{-2}\mathbf{z}^{(k)}\big), \qquad k = n-2, n-3, \dots, 1. \tag{5.83}$$

Page 228: *Revise Exercise 6.1.25:*

6.1.25. Prove from first principles that the sequence (6.24) converges nonuniformly to the step function.

Page 229: *In equation* (6.40)*, delete initial fraction:*

$$\int_{-\pi}^{\pi} s_n(x)\,dx = \frac{1}{2\pi}\int_{-\pi}^{\pi} \frac{\sin\left(n+\frac{1}{2}\right)x}{\sin\frac{1}{2}x}\,dx = \frac{1}{2\pi}\int_{-\pi}^{\pi}\sum_{k=-n}^{n} e^{\,i\,k\,x}\,dx = 1, \qquad (6.40)$$

Page 238: *In the first integral in the displayed equation after* (6.65) *change* $\sinh\omega\,y$ *to* $\sinh\omega\,\xi$*:*

$$u(x) = \int_0^x \frac{\sinh\omega\,(1-x)\sinh\omega\,\xi}{\omega\sinh\omega}\,d\xi \;+\; \int_x^1 \frac{\sinh\omega\,x\,\sinh\omega\,(1-\xi)}{\omega\sinh\omega}\,d\xi$$

Page 239: *At end of line 10 add the following footnote after "case":*

† However, one can suitably extend the notion of Green's function in such situations; see, for instance, a preprint by J. Franklin, Green's functions for Neumann boundary conditions; `arXiv 1201.6059`, 2012.

Page 241: *Change page header to*

6.2 Green's Functions for One-Dimensional Boundary Value Problems

Page 250: *Change line before and equation* (6.105) *to the following:*

Then, by (6.89),

$$\begin{aligned} 1 &= \iint_{D_\varepsilon} \delta(x,y)\,dx\,dy = -\,b\iint_{D_\varepsilon}\Delta(\log r)\,dx\,dy = -\,b\oint_{C_\varepsilon}\frac{\partial(\log r)}{\partial\mathbf{n}}\,ds \\ &= -\,b\oint_{C_\varepsilon}\frac{\partial(\log r)}{\partial r}\,ds = -\,b\oint_{C_\varepsilon}\frac{1}{r}\,ds = -\,b\int_{-\pi}^{\pi}d\theta = -2\,\pi\,b, \end{aligned} \qquad (6.105)$$

Page 250: *In the displayed formula after Theorem 6.17, change* $\mathbb{R}^2$ *to* Ω*:*

$$u(x,y) = -\iint_\Omega G_0(x,y;\xi,\eta)\,\Delta u(\xi,\eta)\,d\xi\,d\eta.$$

In equation (6.108)*, change* $\mathbb{R}^2$ *to* Ω *twice and add brackets to second integrand:*

$$\iint_\Omega \delta(x-\xi)\,\delta(y-\eta)\,u(\xi,\eta)\,d\xi\,d\eta = \iint_\Omega \big[-\Delta G_0(x,y;\xi,\eta)\,u(\xi,\eta)\big]\,d\xi\,d\eta. \qquad (6.108)$$

Page 254: *Change line 1 to*

"The Green's function for the homogeneous Dirichlet boundary value . . . "

Page 258: *Correct left hand side of equation* (6.135)*:*

$$\frac{\partial G}{\partial\rho}(r,\theta;1,\phi) = -\,\frac{1}{2\pi}\,\frac{1-r^2}{1+r^2-2\,r\cos(\theta-\phi)}\,, \qquad (6.135)$$

Pages 276–7: *Correct proof of Proposition 7.10:*

Proof: Note that

$$g(x) = \int_{-\infty}^{x} f(\xi)\, d\xi = \int_{-\infty}^{\infty} \sigma(x-\xi)\, f(\xi)\, d\xi,$$

where $\sigma(x)$ is the step function (6.23). The latter expression is just the convolution integral (7.52) between the two functions:

$$g(x) = \sigma * f(x).$$

Thus, according to the convolution formula (7.55), the Fourier transform of the integral is given (up to multiple) by the product of the individual Fourier transforms:

$$\widehat{g}(k) = \sqrt{2\pi}\;\; \widehat{\sigma}(k)\, \widehat{f}(k).$$

Consulting our table of Fourier transforms, we find

$$\widehat{g}(k) = \sqrt{2\pi}\left(\sqrt{\frac{\pi}{2}}\,\delta(k) - \frac{\mathrm{i}}{\sqrt{2\pi}\,k}\right)\widehat{f}(k) = -\,\frac{\mathrm{i}}{k}\,\widehat{f}(k) + \pi \widehat{f}(k)\,\delta(k) = -\,\frac{\mathrm{i}}{k}\,\widehat{f}(k) + \pi \widehat{f}(0)\,\delta(k),$$

which establishes the desired formula (7.45). *Q.E.D.*

Page 277: *In the displayed equation immediately above the Exercises, delete one factor of* $1/k$ *in the first term after the equals sign*:

$$\widehat{f}(k) = \left(-\,\frac{\mathrm{i}}{k}\sqrt{\frac{\pi}{2}}\; e^{-\,|\,k\,|} + \frac{\pi^{3/2}}{\sqrt{2}}\,\delta(k)\right) - \frac{\pi^{3/2}}{\sqrt{2}}\,\delta(k) = -\,\mathrm{i}\sqrt{\frac{\pi}{2}}\;\frac{e^{-\,|\,k\,|}}{k}\,.$$

Page 278: *In Exercise 7.2.12, insert a factor of* $\sqrt{2\pi}$ *in the formula*

$$\widehat{f}(k) = \sqrt{2\pi}\sum_{n=-\infty}^{\infty} c_n\,\delta(k-n).$$

Page 281: *In Exercise 7.3.6.*(a) *add*

Hint: You may wish to solve Exercise 7.3.12 first.

Page 289: *In Exercise 7.4.10, change* (a) *and* (b) *to* (*i*) *and* (*ii*)

Page 291: *In second paragraph, delete sentence* "We next present ... equations." *and then change* "Finally, we discuss ..." *to* "We next discuss ..."
Add the following sentence at the end of the third paragraph:
The next section presents the Maximum Principle that rigorously justifies the entropic decay of temperature in a heated body and underlies much of the advanced mathematical analysis of parabolic partial differential equations.

Page 310: *In the second displayed formula after equation* (8.63), *insert factor of* $\frac{1}{2}$:

$$u(t,x) = c_1 + c_2\,\mathrm{erf}\left(\frac{x}{2\sqrt{t}}\right).$$

Page 361: *Change page header to*

9.2 Self-Adjoint and Positive Definite Linear Functions

Page 363: *Insert parenthetical comment at the end of the page:*

(The case $q(x) \equiv 0$ can also be positive definite, when subject to suitable boundary conditions, but is treated differently, in accordance with the weighted inner product construction appearing in Example 9.23.)

Page 389: *Change (9.131–132) to the following:*

$$\begin{aligned} u(t,x) &= \sum_{k=1}^{\infty} \left[\, c_k u_k(t,x) + d_k \widetilde{u}_k(t,x) \,\right] \\ &= \sum_{k=1}^{\infty} \left[\, c_k \cos(\omega_k t) + d_k \sin(\omega_k t) \,\right] v_k(x) = \sum_{k=1}^{\infty} r_k \cos(\omega_k t - \delta_k)\, v_k, \end{aligned} \tag{9.131}$$

where (r_k, δ_k) are the polar coordinates of (c_k, d_k):

$$c_k = r_k \cos \delta_k, \qquad d_k = r_k \sin \delta_k. \tag{9.132}$$

Page 391: *Change (9.145) to the following:*

$$0 = \langle\, h - 2\, a\, \omega_k v_k \,, v_k \,\rangle = \langle\, h \,, v_k \,\rangle - 2\, a\, \omega_k \,\|\, v_k \,\|^2, \ \text{ and hence } a = \frac{\langle\, h \,, v_k \,\rangle}{2\,\omega_k \,\|\, v_k \,\|^2}\,, \tag{9.145}$$

Page 392: *Correct sign errors in (9.149):*

$$v_\star(x) = \frac{\sin k\,\pi\,x}{k^2\,\pi^2\,c^2 - \omega^2}\,, \qquad \text{so that} \qquad u_\star(t,x) = \frac{\cos\omega\,t\ \sin k\,\pi\,x}{k^2\,\pi^2\,c^2 - \omega^2}\,, \tag{9.149}$$

and in the last displayed equation:

$$z(0,x) = f(x) \ - \ \frac{\sin k\,\pi\,x}{k^2\,\pi^2\,c^2 - \omega^2}\,, \qquad \frac{\partial z}{\partial t}(0,x) = g(x),$$

Page 393: *In Exercise 9.5.14 change* $h(x) \equiv \sin k\,\pi\,x$ *to* $h(x) = \sin k\,\pi\,x$

Page 406: *On line 4, change* "... special case of (9.75)." *to*

"... special case of (9.75); see also Exercise 9.3.22."

Page 411: *On line 9 in paragraph beginning "The first step ... ", change*

"vertexvertices" *to* "vertices"

Page 413: *In the last equation in (10.32), change* y_k *to* y_l:

$$\begin{aligned} \omega_l^\nu(x_i,y_i) &= \alpha_l^\nu + \beta_l^\nu\, x_i + \gamma_l^\nu\, y_i = 0, \\ \omega_l^\nu(x_j,y_j) &= \alpha_l^\nu + \beta_l^\nu\, x_j + \gamma_l^\nu\, y_j = 0, \\ \omega_l^\nu(x_l,y_l) &= \alpha_l^\nu + \beta_l^\nu\, x_l + \gamma_l^\nu\, y_l = 1. \end{aligned} \tag{10.32}$$

Page 416: *In equation* (10.38)*, change* $\left(\sum_{i=1}^{n} c_i \nabla \varphi_i \right)^2$ *to* $\left\| \sum_{i=1}^{n} c_i \nabla \varphi_i \right\|^2$

Page 417: *Correct last line in equation* (10.45)*:*

$$\begin{aligned} k_{ij}^{\nu} &= \frac{1}{2} \, \frac{(y_j - y_l)(y_l - y_i) + (x_l - x_j)(x_i - x_l)}{(\Delta_\nu)^2} \, |\, \Delta_\nu \,| = - \, \frac{(\mathbf{x}_i - \mathbf{x}_l) \cdot (\mathbf{x}_j - \mathbf{x}_l)}{2 \,|\, \Delta_\nu \,|} \, , \quad i \neq j, \\ k_{ii}^{\nu} &= \frac{1}{2} \, \frac{(y_j - y_l)^2 + (x_l - x_j)^2}{(\Delta_\nu)^2} \, |\, \Delta_\nu \,| = \frac{\|\, \mathbf{x}_j - \mathbf{x}_l \,\|^2}{2 \,|\, \Delta_\nu \,|} \\ &= \frac{(\mathbf{x}_i - \mathbf{x}_l) \cdot (\mathbf{x}_j - \mathbf{x}_l) + (\mathbf{x}_l - \mathbf{x}_j) \cdot (\mathbf{x}_i - \mathbf{x}_j)}{2\, \Delta_\nu} = - \, k_{ij}^{\nu} - k_{il}^{\nu} \, . \end{aligned} \tag{10.45}$$

Pages 418–9: *Change first sentence in Example 10.7 to:*

A metal plate has the shape of an oval running track, consisting of a square, with side lengths 2 m, and two semi-circular disks glued onto opposite sides, as sketched in Figure 10.9.

Page 426: *In Exercise 10.3.16, change* $n = 2$ *in part* (b) *to* $n = 3$ *and change* $n = 3$ *in part* (c) *to* $n = 4$.

Page 434: *In Exercise 10.4.3*(c)*, change* "… wave equation." *to* "… transport equation."

Page 450: *In Exercise 11.2.12, correct the boundary conditions*:

$$u(t, 0, y) = u(t, \pi, y) = 0 = u(t, x, 0), \quad u(t, x, \pi) = f(x), \quad 0 < x, y < \pi, \quad t > 0.$$

Page 464: *At end of line right before equation* (11.90) *add the following footnote:*

† If r is real but non-integral, and $x < x_0$, then one can replace $x - x_0$ by $x_0 - x$ or, alternatively, use absolute values throughout.

Pages 464–5: *In line before equation* (11.91) *change* "… order in the equation are multiples …" *to* "… order in equation (11.88) are multiples …".

In equation (11.91) *and the subsequent formula, change all occurrences of* s, t, r *to* a, b, c*, and add to line separating them:*

$$a_0 \, r \, (r - 1) + b_0 \, r + c_0 = 0, \tag{11.91}$$

where, referring back to (11.71),

$$a_0 = a(x_0), \qquad b_0 = b(x_0), \qquad c_0 = c(x_0),$$

Page 465: *In case* (iii)*, change* $r_2 = r_1 + k$ *to* $r_1 = r_2 + k$*; change "smaller" to "larger", and change* x^{r_2} *to* $(x - x_0)^{r_2}$ *in equation* (11.93)*:*

(*iii*) Finally, if $r_1 = r_2 + k$, where $k > 0$ is a positive integer, then there is a nonzero solution $\widehat{u}(x)$ with a convergent Frobenius expansion corresponding to the larger index r_1. One can construct a second independent solution of the form

$$\widetilde{u}(x) = c \log(x - x_0)\, \widehat{u}(x) + v(x), \quad \text{where} \quad v(x) = (x - x_0)^{r_2} + \sum_{n=1}^{\infty} v_n (x - x_0)^{n+r_2} \tag{11.93}$$

Page 466: *Correct formulas after equation* (11.96) *as follows*:

$$\begin{aligned} u'' + \left(\frac{1}{x} + \frac{x}{2}\right) u' + u &= v \left[\widehat{u}'' + \left(\frac{1}{x} + \frac{x}{2}\right) \widehat{u}' + \widehat{u} \right] + v' \left[2\,\widehat{u}' + \left(\frac{1}{x} + \frac{x}{2}\right) \widehat{u} \right] + v''\, \widehat{u} \\ &= e^{-x^2/4} \left[v'' + \left(\frac{1}{x} - \frac{x}{2}\right) v' \right]. \end{aligned}$$

If u is to be a solution, v' must satisfy a linear first-order ordinary differential equation:

$$v'' + \left(\frac{1}{x} - \frac{x}{2}\right) v' = 0, \qquad \text{and hence} \qquad v' = \frac{c}{x}\, e^{x^2/4}, \qquad v = c \int \frac{e^{x^2/4}}{x}\, dx + b,$$

where c, b are arbitrary constants. We conclude that the general solution to the original differential equation is

$$\widetilde{u}(x) = v(x)\, \widehat{u}(x) = \left(c \int \frac{e^{x^2/4}}{x}\, dx + b \right) e^{-x^2/4}. \tag{11.97}$$

Page 471: *In Figure 11.5, redraw the graphs of* $Y_1(x), Y_2(x), Y_3(x)$:

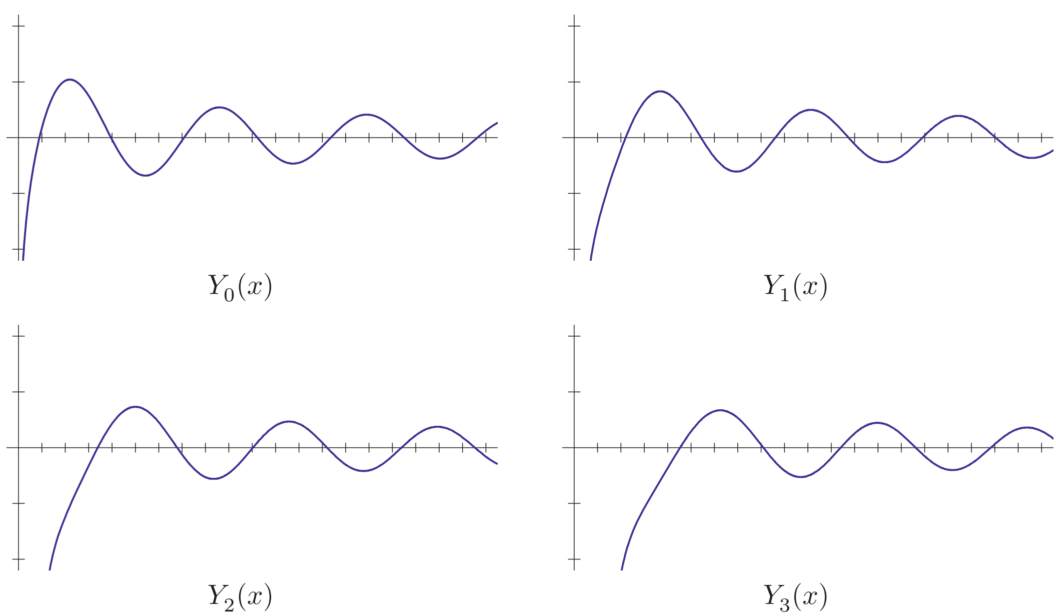

Figure 11.5. Bessel functions of the second kind.

Page 473: *Change page header to*

11.3 Series Solutions of Ordinary Differential Equations

Page 489: *Add movie symbol* *to Figure 11.10.*

Page 495: *Change sentence including* (11.67) *to the following*:

In general, we define the *relative vibrational frequencies* to be the ratios between the individual frequencies and the dominant, or smallest, one. Thus, the relative vibrational frequencies of a circular drum are

$$\rho_{m,n} = \frac{\omega_{m,n}}{\omega_{0,1}} = \frac{\zeta_{m,n}}{\zeta_{0,1}}\,, \qquad \text{where} \qquad \omega_{0,1} = \frac{c\,\zeta_{0,1}}{R} \approx 2.4\,\frac{c}{R}\,. \tag{11.67}$$

Page 499: *In Example 11.15, correct the equation two lines from the end*:

$\zeta_{0,1}/\zeta_{0,2} \approx .43565$

Page 500: *In Exercise 11.6.41, switch the indices on* $\omega_{i,j}$:

(a) $\omega_{0,4}$, (b) $\omega_{2,4}$, (c) $\omega_{4,2}$, (d) $\omega_{3,3}$, (e) $\omega_{5,1}$.

Page 532: *In displayed equation on line -3, change comma to semicolon in* $v(\mathbf{x};\boldsymbol{\xi})$

Page 548: *In equation* (12.131), *add* t *dependence to* $u_{0,0,n}$ *and* $\widehat{u}_{0,0,n}$, *and correct denominators in final expressions*:

$$\begin{aligned} u_{0,0,n}(t,r,\varphi,\theta) &= \cos(c\,n\,\pi\,t)\;S_0(n\,\pi\,r) = \frac{\cos c\,n\,\pi\,t\;\sin n\,\pi\,r}{n\,\pi\,r}\,, \\ \widehat{u}_{0,0,n}(t,r,\varphi,\theta) &= \sin(c\,n\,\pi\,t)\;S_0(n\,\pi\,r) = \frac{\sin c\,n\,\pi\,t\;\sin n\,\pi\,r}{n\,\pi\,r}\,, \end{aligned} \qquad n = 1,2,3,\ldots \tag{12.131}$$

Page 553: *In equation (12.145) and the next displayed equation, the limit is as* $t \to 0$:

$$\lim_{t\to 0} \mathrm{M}_{ct}\,[\,f\,] = \mathrm{M}_0\,[\,f\,] = f(\varnothing). \tag{12.145}$$

$$\lim_{t\to 0} \langle\, u(t,\cdot)\,,f\,\rangle = \langle\, u(0,\cdot)\,,f\,\rangle = 0 \qquad \text{for } \textit{all} \text{ functions} \quad f,$$

Page 555: *Replace the period in equation* (12.151) *by a comma, and replace the following sentence by*

where $\mathrm{M}^{\mathbf{x}}_{ct}\,[\,g\,]$ denotes the average of the initial velocity function g over the sphere $S^{\mathbf{x}}_{ct} = \{\,\|\,\boldsymbol{\xi} - \mathbf{x}\,\| = c\,t\,\}$ of radius $c\,t$ centered at the point $\mathbf{x}$. Thus, the value of our solution at position $\mathbf{x}$ and time $t > 0$ only depends upon the initial data a distance $c\,t$ away from the point $\mathbf{x}$.

Page 577: *Change page header to* B.2 Bases and Dimension

Page 592: *In reference* [89] *change* 2005 *to* 2006

Page 603: *Add entry*: Franklin, J. 239

Page 605: *Change page header to* Author Index

Page 607–636: *Changes and additions to the index*: