Boyce/DiPrima, Elementary Differential Equations and Boundary Value Problems
Changes in the 10th edition

REVISIONS IN CHAPTER 1
Section 1.1
2 lines above Eq. (3). Phrase inserted.
end of Example 2. Equilibrium solution is identified as the terminal velocity.
Figures 1.1.2 and 1.1.3. Captions expanded to include the differential equation.
Figure 1.1.4. Caption expanded to include the differential equation.
Problem 25, part (a). Clarified the magnitude and direction of the drag force.

Section 1.2
Figure 1.2.1. Caption expanded.
4 lines below Eq. (26). Replaced "heavy" by "black."
Figure 1.2.2. Caption expanded.

References
Some additions have been made to the References

REVISIONS IN CHAPTER 2
Section 2.1
There is a new Example 1. Other examples renumbered. There is some renumbering of equations.
Example 2. Statement of problem has been modified to ask for the general solution and to mention integral curves.
2 lines below Eq. (19). replaced "heavy" by "black."
Figure 2.1.1. Caption expanded to include direction field and the initial point for the black curve.
Example 3. Statement of problem modified to ask for general solution.
Figure 2.1.2. Caption expanded to mention direction field.
2 lines below Eq. (38). replaced "heavy" by "black."
Figure 2.1.3. Caption expanded to include the initial point for the black curve.

Section 2.2
line 1. deleted reference to Section 2.1.
text following Eq. (13). Sentence added at the end of this paragraph.
1 line below Eq. (24). replaced "heavy" by "black."
Example 2. Last two sentences have been revised.
Figure 2.2.2. Caption expanded to explain the meaning of the black curve.
Figure 2.2.3. In the caption replaced "heavy" by "black".

Section 2.3

Figure 2.3.2. Caption expanded to include a statement of the initial value problem.
Figure 2.3.3. Caption expanded to include a statement of the initial value problem.
Problem 10. This problem has been revised
Problem 11. This problem is new.
Problem 12. This is a revision of former Problem 11.
Problem 13. This is former Problem 12. The old Problem 13 has been deleted.
Problem 14 and following Problems are unchanged.

Section 2.4
Problem 22. used radical sign in the DE to emphasize that positive square root is intended.

Section 2.5
End of paragraph preceding Eq. (8). Sentence added saying that solutions in the intervals (0,K) or (K, infinity) cannot leave these intervals.
Figure 2.5.4. Caption expanded to include the initial condition for the black curve.
Example 1. Added a sentence at the end of this example referring to the black curve in Figure 2.5.4.

Section 2.6
Example 1. Small changes made in text surrounding Eqs. (4) and (5). Integral curves are mentioned after Eq.(5).
Theorem 2.6.1. Some changes in the text immediately preceding this theorem.
Eqs. (14) and (15). Sentence added between these two equations to clarify the reasoning.
above Eq. (27). Derivation leading to this equation has been rewritten to refer directly to Eq. (26).
Example 4. Example expanded to include the details of solving the modified equation.

Section 2.7
Equation 2. Changed coefficient of y from -1/2 to - 0.5; fits better with numerical computation later.
Figure 2.7.1. Caption expanded to include the differential equation.
Equation 11. Changed coefficient of y to - 0.5.
two lines below Eq. (12). Changed - y/2 to -0.5y.
Table 2.7.1, heading of table. Changed coefficient of y to - 0.5.
Figure 2.7 3. Caption expanded to include the step size and the initial value problem.
Example 2, first equation. Changed coefficient of y to -0.5.
Table 2.7.2, heading of table. Changed coefficient of y to -0.5.

Problems. Introductory paragraph modified.

Section 2.8
Figure 2.8.1. Caption expanded to include the mention of Picard iterates and the initial value problem.
Example. Added a few details to clarify the uniqueness argument from Eq. (21) to the end of the example.
Problems 7 and 8. New part (c) added (show sequence converges).

Section 2.9
near the end of the text. New footnote for Robert M. May.

REVISIONS IN CHAPTER 3
Section 3.1
Figure 3.1.1. Caption expanded.
Figure 3.1.2. Caption expanded.

Section 3.2
Two lines below Eq. (11). Sentence added to point out that the denominators are the nonzero determinant W.
Four lines below Eq. (11). Paragraph has been expanded to explain what happens when $W = 0$.
Following Example 6. New Theorem 3.2.6 has been inserted stating that the real and imaginary parts of a complex solution are also solutions. Former Theorem 3.2.6 is renumbered as Theorem 3.2.7.

Section 3.3
Figure 3.3.1. Caption expanded.
Five lines above Eq. (19). This passage leading up to Eq. (19) revised to make use of Theorem 3.2.6.
Subsection on Complex Roots; The General Case. First paragraph of this subsection has been revised to take advantage of Theorem 3.2.6.
Figure 3.3.2. Caption expanded.
Figure 3.3.3. Caption expanded.
Problem 32 has been replaced by a new problem. (Former Problem 32 is now Theorem 3.2.6.)

Section 3.4
Figure 3.4.1. Caption expanded.
Example 2. After Eq. (23) the graph is stated to be the blue curve in Figure 3.4.2. In the next paragraph the other solution corresponds to the black curve.
Figure 3.4.2. Caption expanded to explain the blue and black curves, respectively.
Example 3. Last paragraph has been expanded by introducing the variable w to make the solution process more clear. Also in Eq. (34) it is explicitly noted

that W is not zero for t > 0.
Problems 20 and 32. Corrected reference to Abel's formula for the Wronskian.
Problem 31. This problem has been deleted. Problems 32 through 46 have been renumbered 31 through 45. Answers have been similarly corrected.

Section 3.5
After Theorem 3.5.2. Step 3 has been reworded.
Example 2. Explanation of Eq. (12) modified.
Example 5. The explanation just above Eq. (26) has been expanded.
Just below Eq. (30). This sentence has been expanded for clarity.
Problems 3 and 4. These problems are new. The following problems are renumbered.

Section 3.6
Between Eqs. (8) and (9). An unnumbered equation has been inserted to make the substitution step more transparent.

Section 3.7
discussion of Eqs. (2) and (3). There is greater emphasis on the distinction between the forces in the static problem and the dynamic problem.
Example 1. Second sentence slightly revised for smoothness.
Eqs. (11) and (12). A sentence has been added between these two equations for improved clarity.
Below Eq. (21). The characteristic equation for Eq. (21) is displayed.
just above Figure 3.7.6. Sentence added saying that in critically damped or overdamped cases the mass may pass through equilibrium at most once.
Figure 3.7.8. Caption expanded to explain the meaning of tau.
Problem 27. Added footnote on Archimedes.

Section 3.8
Figure 3.8.1. Caption expanded to include the initial value problem.
Figure 3.8.4. Caption expanded.
Figure 3.8.5. Caption expanded.
Figure 3.8.6. Caption expanded.
Figure 3.8.7. Caption expanded.
Example 4. This example is new and is intended to provide a home for Figure 3.8.8.

REVISIONS IN CHAPTER 4
Section 4.1
Example 2. This example is expanded to make the logic more clear and to display the linear relation among the four given functions.
second paragraph before Problems. Short new paragraph has been inserted

referencing undetermined coefficients and variation of parameters (Sections 4.3 and 4.4).
Problem 20. reference to Abel's theorem (3.2.7) has been corrected.

Section 4.2
After Eq. (1). We specify that $a_0 \neq 0$. Later this implies that Z(r) is of degree n.
Figure 4.2.1. Caption expanded to include the initial value problem.
first paragraph following the end of Example 1. The last two sentences of this paragraph have been modified.
Figure 4.2.2. Caption expanded to include the initial value problem.
Figure 4.2.3: New caption describes the two curves more fully.
Below Eq. (18). We note that Problem 41 applies both to real and complex roots. Also that a DE must be of order at least four to have repeated complex roots.

Section 4.4
derivation of the system (11). The passage between Eq. (5) and Eq. (11) has been rewritten and expanded somewhat. Equation (6) is new so the remaining equations have been renumbered.
Example 1. A sentence has been added at the end of this example.

REVISIONS IN CHAPTER 5
Section 5.1
item 5. This paragraph was expanded to include more precise statements about series that converge either for all x, or only for $x = x_0$.
items 6 and 7. Since the word "series" can be either singular or plural, the word "two" was inserted for clarity. Also, in item 7, clarified that the condition on $g(x_0)$ justifies division by g(x).

Section 5.4
Equation (4). the middle line in this chain of equations has been added.
Equations (10) and (11). The text leading from Eq. (10) to Eq. (11) has been revised to make the steps in the argument clearer. The unnumbered equation between Eqs.(10) and (11) has been inserted.
below Eq. (17). Theorem 3.2.6 is invoked to obtain real-valued solutions.

Section 5.5
above Eq. (7). The unnumbered equation has been inserted to make clear why the coefficients in Eq. (4) are "Euler coefficients" times power series.

Section 5.6
above Eq. (15). Added a little more description of how Eq. (15) is obtained.
paragraph following Eq. (17). First sentence of this paragraph has been

expanded.
Theorem 5.6.1. An introductory sentence has been inserted before the theorem.

Section 5.7
Figure 5.7.1. Caption expanded.
Figure 5.7.2. Caption expanded.

REVISIONS IN CHAPTER 6
Section 6.1
Example 1. A displayed equation is added to show what happens when c = 0.
below Example 3. A footnote has been added in the definition of piecewise continuity to include open or half-open intervals.
Example 8. Reference to Example 6 has been corrected to refer to Example 7.
Problems 21 through 24 are new. Following problems have been renumbered 25 through 31.

Section 6.2
Theorem 6.2.1. Several additions have been made in the proof of this theorem. The integral appearing in the first line of the proof has been identified as the one whose limit (if it exists) is the transform of f'. The purpose of the following manipulations is mentioned. Later, the equation now numbered (2) was formerly unnumbered. Following this equation, there is a fuller description of the limiting process.
Equation (3). This equation has been expanded to show the intermediate step.
Equations (3) through (6). These equations were formerly numbered (2) through (5). The former equation (6) has lost its number, so equations numbered (7) or higher remain the same.
fourth paragraph below Eq. (16). Sentence added about the continuity of the solution of the IVP (5), (6)
Problem 27. New problem. Following problems have been renumbered 28 through 39.

Section 6.3
Equation (1). The constant c is no longer required to be nonnegative. But a sentence is added to say that nonnegative c is what interests us.
above Eq. (4). "for $c \geq 0$" has been inserted. For $c < 0$ the LT of u_c is 1/s rather than Eq. (4).
Figures 6.3.7 through 6.3.10. Captions have been expanded to refer to the appropriate problem.

Section 6.4
Example 1. Added another line to Eq. (9) to clarify the algebraic manipulation.

Figure 6.4.1. Caption expanded to include the initial value problem.
Figure 6.4.2. Added reference to Eq. (20) in the caption.

Section 6.5
after Eq. (1). inserted "for some tau > 0".
Eqs. (5) and (6). changed limit to one-sided limit in these equations, and also in text above Eq. (5) and in caption to Figure 6.5.2.
after Eq. (12). Footnote on L'Hospital has been added.
Figure 6.5.3. Caption expanded to include the initial value problem.

Section 6.6
Equation (11). Sentence preceding this equation has been revised.

REVISIONS IN CHAPTER 7
Section 7.2
Property 4. While complex numbers include the real numbers, students may think of them as separate, so we specify either is acceptable.
Property 7. The results of Eqs. (13) and (15) are now said to be real or complex numbers.
Property 9. The augmented matrices in the example (and elsewhere in this chapter) now have a single vertical rule rather than a shorter rule in each row.
Property 9. footnote on Gauss has been expanded.
Property 9. The paragraph following Example 2 now includes a sentence stating the conclusion when every element in the first column is zero. At the end of this paragraph there is a statement about the occurrence of a zero diagonal element later in the process.
end of section (just above Problems). short paragraph has been added to say that some operations are done element by element, but others are not.
Problem 20. Problem statement has been corrected and reworded.

Section 7.3
subsection heading changed to Linear Dependence and Independence.
just above Eq. (17). coefficients are now said to be real or complex.
Equation (18). This continued equation is now split into two parts.
below Equation (27). This equation is now identified as the characteristic equation of the matrix A. It is also stated that the eigenvalues may be either real or complex.
Equation (29). This equation now shows the expanded form of the characteristic equation for a 2 by 2 matrix. The previous Eq. (29) is still there but is unnumbered.
Equation (32). equation expanded to include the factorization.
paragraph surrounding Eq. (38). some changes of wording in this paragraph; q is specified to be an integer.

Section 7.4
three lines below Eq. (4). new Theorem 7.4.5 is included in the reference.
Eq. (8), [formerly Eq. (5)] has been moved to the following paragraph.
proof of Theorem 7.4.2. first sentence of second paragraph has been slightly revised.
Equation (15). Sentence following this equation has been modified to refer to Theorem 3.2.7 as well as to Eq. (23).
Theorem 7.4.5 and its proof have been added.
Problem 1 has been reworded.

Section 7.5
below Eq. (2). The specified behavior of solutions takes place "as t increases".
Example 1. This example is new. The text immediately before and after the example has been slightly modified as well. The other examples and equations in this section are renumbered.
Example 2. Paragraph preceding this example has been expanded.
Example 2. Paragraph following Eq. (9) has been expanded to state overall behavior of solutions more completely.
Equation 11. The factorization is shown.
Examples 2 and 3. Instructions have been modified to include the term "phase portrait."
Figures 7.5.2 and 7.5.4. Caption has been modified to include "phase portrait". The text has also been modified so as to use this term.
Figure 7.5.4(a). Scales on the two axes should be the same so that the eigenvectors (which are orthogonal) appear to be orthogonal.

Section 7.6
Example 1. Instructions are somewhat modified.
following Eq. (9). We now refer to Theorem 7.4.5 rather than Section 3.3.
Figure 7.6.2. Caption of part (a) modified to include "phase portrait"; caption of part (b) expanded to say that graphs of x_2 are similar.
Example 1. The last paragraph of this example is new.
Figure 7.6.4(b). Arrow on the dashed curve should point up indicating clockwise motion.

Section 7.7
Example 1. Reference to Section 7.5 is revised to refer to Example 2 in that section.
Example 3. Again the reference to Section 7.5 is revised to refer to Example 2.
Problem 8. Answer corrected. Minus sign inserted before second element in the first row.

Section 7.8
first paragraph. Replaced k by m for algebraic multiplicity.

Equation (4). Factorization of the polynomial is included in the equation.
paragraphs between Examples 1 and 2. Again replaced k by m.
paragraph preceding Example 2. Last part of this paragraph has been made more specific (in the reference to previous results).
following Eq. (16). Statement concerning the solvability of Eq. (16) has been clarified.
one line below Eq. (19). it is noted that the Wronskian is nonzero.
last paragraph of Example 2 (below Eq. (20)). The first part of this paragraph has been rewritten. The term "phase portrait" is used. The calculation showing the limit as t -> - infinity is shown. Most important, the statement about an asymptote as t approaches infinity has been fixed.
Caption for Figure 7.8.2a. Caption now identifies the figure as a phase portrait.
below Eq. (24). A sentence and a new unnumbered equation has been added.
footnote on Jordan has been expanded.
below Eq. (35). This paragraph has been modified somewhat. The next paragraph (the last in the section) is new.
Problem 17. This problem is new.
former Problems 17 -- 21. have been renumbered 18 -- 22.
(new) Problem 19. parts (c) and (d) are revised from former Problem 18.

Section 7.9
Problem 18. New problem.

REFERENCES
Reference to Brannan/Boyce updated.

REVISIONS IN CHAPTER 8
Section 8.1
We have inserted a brief derivation of the Euler method before stating the formula -- that is, former Eqs. (8) and (9) have been moved up and are now Eqs. (3) and (4). Other equations have been renumbered appropriately. This should make this section more self-contained.
below Eq. (6). The pseudocode for the Euler method is enclosed in a box to set it out from the text.
subsection Errors in Numerical Approximations. This subsection has been substantially revised.
subsection Local Truncation Error for the Euler Method. Equation (21) has been added along with some accompanying changes in the text. Later in the subsection the discussion of the global truncation error has been shortened but Eq. (25) has been added to make the bound explicit.
Problem 23. wording in part (b) has been slightly modified; part (c) has been

revised to be consistent with changes in the text.

Section 8.2
after Example 1. The pseudocode for the improved Euler method is given a title and enclosed in a box.

Section 8.3
above Eq. (4). The pseudocode for the Runge-Kutta method is given a title and enclosed in a box.

Section 8.4
footnote on J. C. Adams. footnote has been expanded.
footnote on Francis Bashforth. footnote is new.

Section 8.5 (formerly 8.6)
after Eq. (5). We make explicit that f_0 is the tangent vector at x_0 and f_1 is the tangent vector at x_1.

Section 8.6 (formerly 8.5)
second paragraph before Example 2. This paragraph has been expanded and the unnumbered equation inserted to make the derivation more clear.
Figure 8.6.2. Caption expanded.
Example 3. This material has been rewritten in the form of an Example rather than text. More significantly, the DE has been converted to a system and discussed primarily in that context.

REVISIONS IN CHAPTER 9
Section 9.1
First five paragraphs (up to Case 1). This material has been significantly revised so as to make it more clear what the chapter is about, and especially why this section is here.
Case 2. This subsection has been revised to include a mention of what happens as t approaches minus infinity.
Case 4. Discussion immediately surrounding Eqs. (11) and (12) has been revised to be more specific.
Case 4. Paragraph surrounding Eq. (18) has been modified.
Problem 18. New part (a) has been inserted.
Problem 22. This new problem has been added.

Section 9.2
below Eq. (3). The use of the unit vectors i and j has been avoided (since we haven't used them in similar situations elsewhere).
Figures 9.2.4 and 9.2.5. Captions have been expanded.
Figure 9.2.6. Caption has been expanded.

Figure 9.2.7. Caption has been expanded.
Example 4. The last few lines of this example have been expanded.
Figure 9.2.8. Caption has been expanded. Separatrix is to be made black.
footnote on Duffing. Added the title of his monograph.

Section 9.3
after Eq. (10). Definitions of x and f(x) have been added.
discussion of Theorem 9.3.2 and Table 9.3.1. Two sentences added to explain more fully the possible effect of small nonlinear terms when the eigenvalues are pure imaginary or real and equal.

Section 9.4
Example 1
case x = 0, y = 0. First and last sentences are revised to state more accurately what happens to the populations.
case x = 1, y = 0. Beginning and end of this subsection are revised.
case x = 0, y = 0.75. Beginning and end are revised.
end of Example 1. Sentence added to mention "basin of attraction."
Figure 9.4.4. Separatrix is to be made black. Caption expanded to mention this.
footnote on Hodgkin/Huxley has been expanded.

Section 9.7
Figure 9.7.1. Caption has been expanded.
footnote on Lord Rayleigh has been expended.
footnote on Eberhard Hopf has been expanded.

References. James Gleick's book has been added.

REVISIONS IN CHAPTER 10
Section 10.2
Figure 10.2.1. Caption expanded.
below Eq. (3). Proof for the product of two periodic functions is mentioned.
Table 10.2.1. Value for m = 21 is included in table to support statement in text.
Figure 10.2.2. Caption expanded.

Section 10.3
Figure 10.3.2. Caption expanded.

Section 10.4
above Eq. (8). Reference to Eqs. (5) and (6) has been inserted.
Figure 10.4.2. Caption expanded.

Section 10.5
after Eq. (5). Sentence added to explain the notation.
after Eq. (18). Principle of superposition is mentioned.

Section 10.6
above Eq. (9). We now state explicitly that v_t is zero.
Eq. (31). Text surrounding this equation has been revised to explain why the hyperbolic functions are introduced.

Section 10.7
third paragraph. violin string has been replaced by guitar string.
separate subheadings for problem with nonzero initial velocity and for the general problem
above and below Eq. (32). Eqs. (17) and (18) are now repeated so that the derivation is self-contained.
Figure 10.7.5. This figure is new and caption has been expanded.
paragraph following Eq. (27). The text referring to Figure 10.7.5 has been revised.

Section 10.8
between Eqs. (10) and (11). Unnumbered displayed equation has been inserted.

Appendix B
first paragraph. violin string has been replaced by guitar string.

REVISIONS IN CHAPTER 11
Section 11.2
after Eq. (4). The term "regular" BVP is explicitly defined. In the discussion of boundary conditions that follows in the next paragraph the need for some of the coefficients to be nonzero is noted.
between Eq. (13) and Eq. (14). two explanatory clauses added to make the derivation clearer.
Theorem 11.2.2 and proof. lambda_1 and phi_1 are replaced by lambda_m and phi_m; lambda_2 and phi_2 are replaced by lambda_n and phi_n. This is to avoid the possible inference that we are dealing only with the first two eigenvalues and eigenfunctions, and to be more consistent with Eq. (22).

Section 11.6
end of Example 1. Sentence added to refer to Example 1 in Section 10.3.