DISCRETE MATHEMATICS WITH APPLICATIONS, 4th Edition
by Susanna S. Epp

Great effort was made to insure as error-free a product as possible. With approximately 3 million characters in the book, however, some mistakes are inevitable. I would be grateful to learn of any errors you find so that they can be listed on this page and corrected in subsequent printings. Please send them to me at susanna.s.epp@gmail.com.

With thanks,   Susanna S. Epp

ERRATA

CHAPTER 1

Text

LOCATION	CORRECTION
11 – **Example 1.2.5**	In the solution to part (a), change "(2.1)" to "(2,1)".
15 – **Example 1.3.1**	In line 9 of the solutions, change "which is an integer" to "which is not an integer".

Exercises

LOCATION	CORRECTION
6 – 1.1 #3	Change "$a < c < b$" to "c is between a and b".
13 – 1.2 #8	Change the second occurrence of letter b to c, and part (d) has an answer in Appendix B.
13 – 1.2 #9	The exercise letter f should be boldface.
A5 – 1.2 #11	**a.** $A \times B$ has $4 \cdot 2 = 8$ elements. **b.** $B \times A$ has $2 \cdot 4 = 8$ elements. **c.** $A \times A$ has $4 \cdot 4 = 16$ elements. **d.** $B \times B$ has $2 \cdot 2 = 4$ elements.
21 – 1.3 #4a	Change "Is (-2) V (-6)?" to "Is (-2) V 8?"
A5 – 1.3 #5a	Change the last part to "(-1) S (-2) because -1 ≥ -2."

CHAPTER 2

Text

LOCATION	CORRECTION
41 – **Example 2.2.3**	In line 6, change "p is true and q is false" to "p is true and r is false".
45 – **Top definition**	Change "It p and q" to "If p and q".
45 – **below Example 2.2.8**	Change "the some time that" to the same time that".
46 –**Example 2.2.9**	In line 1 of the solution change "answes" to "answers".
57 – **line 4**	Change "by (d)" to "by (b)".
83 – **bottom figure**	In the diagram for the full-adder, the shape is correct but the label should say 'OR' rather than 'AND'. Also, for consistency with the table, change "S" to "C" and "T" to "S".
94 – **2.5 #21**	The 'AND' label is correct, but the shape is for an 'OR' gate. It should be changed to the shape for an AND-gate. Part (a) has an answer in Appendix B.

Exercises

LOCATION	CORRECTION
38 – 2.1 #46	Part (a) has an answer in Appendix B.
A10 – 2.3 #7 & #8	The premises do not include $\sim q$.

CHAPTER 3

Exercises

LOCATION	CORRECTION
A15 – 3.1 #23	Add: $\forall$ equilateral triangles x, x is isosceles.
116 – 3.2 #24b	Change to: "All the integers greater than 5 that end in 1, 3, 7, or 9 are prime. All the integers greater than 5 that are prime end in 1, 3, 7, or 9."
117 – 3.2 #34a	Change "between 1 and $\sqrt{n}$ strictly" to "between 1 and $\sqrt{n}$ inclusive".
A-17 – 3.3 #34a	Change "strictly between 1 and $\sqrt{n}$ " to "between 1 and $\sqrt{n}$ inclusive".
A-19 – 3.3 #53a	Change "False" to "True. Circle b and squares h and j have the same color."

CHAPTER 4

Text

LOCATION	CORRECTION
145 – line 18	Change "Would 1 have been..." to "Would I have been..."
148 – Definition box	After "In symbols:" add "For all integers $n > 1$,"
184 – Theorem 4.4.2	Change the title to "The Parity of Consecutive Integers"
189 – Test Yourself #1	In line 2 change "$d \geq 0$" to "$d > 0$".
199 – Example 4.6.2	In line 2 change "proof of this port" to "proof of this part".
212 – line 8	The Catalan conjecture was proved by Preda Mihăilescu: "Primary Cyclotomic Units and a Proof of Catalan's Conjecture." *J. reine angew. Math.* **572**, 167-195, 2004.

Exercises

LOCATION	CORRECTION
A-20 – 4.1 #4	In line 2 change "$m > 0$ and $n > 0$" to "$m > 1$ and $n > 1$".
162 – 4.1 #26	In line 2 change "exericse" to "exercise".
168 – 4.2 #14	Change "Consider the statement: The square" to "Consider the statement: The cube".
178 – 4.3 #14	In the second-to-last line, change "where r" to "where t".
A-23 – 4.3 #36, line 5	Change "is not divisible by 5" to "is divisible by 5".
189 – 4.4 #24	Change "if $m \bmod 5 = 2$ and $n \bmod 3 = 6$ then $mn \bmod 5 = 1$" to "if $m \bmod 5 = 2$ and $n \bmod 5 = 1$ then $mn \bmod 5 = 2$".
A-25 – 4.4 #44	*Hint:* There are four cases: Either x and y are both positive, or x is positive and y is negative, or x is negative and y is positive, or both x and y are negative.
A-25 – 4.5 #14	In line 3, change "$2 = 1 = 1$" to "$2 - 1 = 1$".
A-26 – 4.6 #9a	In lines 7 and 9, change "sum" to "difference".
A-27 – 4.6 #31a	In lines 5 and 6, change " $\sqrt{ns}$ " to " $\sqrt{n}\,s$ ".
213 – 4.7 #22	Change "any integer" to "any positive integer".

CHAPTER 5

Text

LOCATION	CORRECTION

239 – line 3	In part (b) change "$\binom{4}{0}$" to "$\binom{4}{4}$".
241 – line 4 from bottom	Change "representation of a" to "representation of n".
249 – lines 20-22	Change "$k^2 + 3k + 1$" to "$k^2 + 3k + 2$" (once in each line), and add an equal sign in line 20.
253 – line 3 of Proof	On the right hand side of the equation, change i to n.
263 – line 15	Change "$n \geq 0$" to "$n \geq 1$".
264 – line 8	Change "$k \geq 0$" to "$k \geq 1$".
264 – lines 10 & 11	Delete the sentence "By definition of divisibility…".
265 – lines 3 and 20	This is Theorem 5.3.3. Line 20: change "$k \geq 3$" to "$k \geq 1$".
308 – Definition box	In line 5, change "$a_0 r'''$" to "$a_0 r^n$".
314 – line 19	Change "foud" to "found".
322 – line 4 from bottom	Change the last sentence of the paragraph to: "If the roots are complex but both a_0 and a_1 are real, then C and D will also be real and equal to each other."
324 – equations 5.8.9	Delete "$= t^2$" in the middle of the equations.
328 – quotation	In line 1, change "GENTE" to "GENIE".

Exercises

LOCATION	CORRECTION
A-31– 5.1 #33	Change "1/(1!)" to "1/(1^2)".
A-31– 5.1 #37	Change the lower index of the summations from k to i.
A-31– 5.1 #40	Change the lower index of the summations from k to i.
A-34 – 5.2 #13	In the last line, change "$n \geq 0$" to "$n \geq 2$".
258 – 5.2 #33	Delete the H next to the exercise number. The exercise has a complete answer in Appendix B.
A-38– 5.3 #37	Change "Theorem 4.2.2" to "Theorem 5.2.2".
268 – 5.3 #40b	In line 2, change "integers" to "positive integers".
277 – 5.4 #4	In line 4, change "$n \geq 0$" to "$n \geq 1$".
277 – 5.4 #10	Change "any collection of n coins" to "n¢" and change "$n \geq 14$" to "$n \geq 8$".
289 – 5.5 #9	Change "and $a \geq -1$" to "and, in either case, $a \geq -1$".
303 – 5.6 #27	The right-hand side of the equation should be $F_k F_{K+1} - F_{k-1} F_{k+1}$.
304 – 5.6 #40	Change "Let t" to "Let t_n".
315 – 5.7 #6	In line 2, change "b_t" to "b_1".
315 – 5.7 #16	Change "18(c)" to "17(c)".
316 – 5.7 #30, 35, 39	These blue exercise numbers should be boldface.
316 – 5.7 #53	Add an H next to this exercise number.

CHAPTER 6

Text

LOCATION	CORRECTION
338 – bottom 3 lines	Change "$2r = 3$" to "$2r = -3$", "$r = 3/2$" to "$r = -3/2$", and "but 3/2 is not" to "but -3/2 is not".
342 – Notation box	In the bottom line, right side, change "[-∞,b)" to "(-∞,b]".
345 – line16	Change "Suppose further that boundaries are assigned to the regions representing A_2, A_3, and A_4" to "Suppose further that boundaries are assigned to the regions representing A_1, A_2, A_3, and A_4".

368 – line15	Change "not in A" to "not in either A or C."
374 – table, right column	In boxes 2, 3, and 10 (of set properties) change the symbol "$\equiv$" to "$=$".

Exercises

LOCATION	CORRECTION
A-51 – 6.1 #22b	Change the union symbols to intersection symbols.
A-55 – 6.3 #14	Change to: "*Hint*: The statement is true."
A-55 – 6.3 #15	Change "*Sketch of proof*" to "*Sketch of part of proof*".
A-56 – 6.3 #36	In line 1, change "A, B, and C" to "A and B".
A-57 – 6.4 #4	In line 4, change "48" to "1".
A-58 – 6.4 #12	Change Hint (1) to: "The universal bound law $a + 1 = 1$ can be derived without using the associative law by using $(a + 1) \cdot (a + \bar{a}) = a + (1 \cdot \bar{a})$. Similarly, $a \cdot 0 = 0$ can be derived using $(a \cdot 1) + (a \cdot \bar{a}) = a \cdot (1 + \bar{a})$. To derive the absorption laws without using the associative law, note that $$a + (a \cdot b) = (a \cdot 1) + (a \cdot b) = a \cdot (1 + b) = a \cdot (b + 1) = a \cdot 1 = a.$$ The other absorption law can be derived using the same sequence of steps but changing each $+$ to $\cdot$ and each $\cdot$ to $+$." Change Hint (4) to "The other associative law can be derived using hints (2) and (3) but changing each $+$ to $\cdot$ and each $\cdot$ to $+$."

CHAPTER 7

Text

LOCATION	CORRECTION
385 –Figures	The top and bottom figures should be labeled 7.1.2 and 7.1.3, respectively.
386 – line 5	Delete the word "binary".
393 – line 9	Change "Exercise 38" to "Exercise 40".
406 – line 7 from bottom	Add: "and for any real numbers y and a with $y > 0$".
407 – line 6	Add "with $b \neq 0$ and $c \neq 0$."
417 –Definition box	In line 1, change "$g: Y \rightarrow Z$" to "$g: Y' \rightarrow Z$"
426 – line 15	Change "such that $f(y) = z$" to "such that $g(y) = z$".
447 – lines 14-15	Change "Tak Kurosawa, 0114910" to "Tak Kurosawa, 011410" and "Mary Lazars, 0103910" to "Mary Lazars, 010310".

Exercises

LOCATION	CORRECTION
394 – 7.1 #17b	Change "2" to "-2".
396 – 7.1 #35	In line 2, change the co-domain to be **Z**, the set of all integers.
396 – 7.1 #36	In line 2, change the co-domain to be **Z**, the set of all integers, and in line 5 change "student F" to "student D".
415 – 7.2 #26	Change "$\mathbf{Z}^+ — \mathbf{Z}^{+}$" to "$\mathbf{Z}^+ \rightarrow \mathbf{Z}^{+}$".
A-61 – 7.2 #27a	Change "T is not one-to-one" to "T is one-to-one".
416 – 7.2 #56b	Change to: "In Section 9.2 we show that there are 2^n strings of 0's and 1's that have length n. What can you conclude about the number of subsets of $\mathscr{P}(X)$? (This provides an alternative proof for Theorem 6.3.1.)"
426 – 7.3 Directions for 1- 2	Change "$G \circ F$" to "$g \circ f$".
A-63 – 7.3 #21	In the next-to-last line, change "$h(f(x)$" to "$h(f(x))$".

CHAPTER 8

LOCATION	CORRECTION
453 – Example 8.2.2	In the bottom line of the example statement, replace a comma by a period: that is, change "c, Is *R...*" to "c. Is *R...*".
482 – Theorem 8.4.3	In parts 1 and 2, delete "[-2pt]". In part 4, change "integers" to "positive integers".
483 – line 2	Change "$a \equiv b$ (mod *n*) and $c \equiv d$ (mod *n*)" to "$a \equiv c$ (mod *n*) and $b \equiv d$ (mod *n*)".
491 – 2nd line from bottom	Change "present" to "prevent".
493 – line 11	Change "Section 3.4" to "Section 5.4".
495 – line 18	Change lines 16-18 to the following: If *M* is not relatively prime to *pq*, then $p \mid M$ or $q \mid M$. If $p \mid M$, then $M^{ed} \equiv 0 \equiv M$ (*mod p*), and if $q \mid M$, then $M^{ed} \equiv 0 \equiv M$ (*mod q*). If $q \nmid M$, then, as above, $M^{ed} \equiv M$ (*mod q*), and if $p \nmid M$, then, as above, $M^{ed} \equiv M$ (*mod p*).
506 – second definition	In line 3, change "for all *a* and *b* in *A*" to "for all *a* and *b* in *B*".

LOCATION	CORRECTION
459 – 8.2 #51	Change "*R′*" to "R^b".
476 – 8.3 #20 & #32	Delete the *H* next to these exercise numbers. These exercises have complete solutions in Appendix B.
A-69 – 8.3 #20	Delete the word "*Hint*" and change "exercise 15 in Section 10.2" to "exercise 12 in Section 8.2".
A-69 – 8.3 #26	Change "exercise 17" to "Example 8.2.4".
A-70 – 8.3 #32	Change "*Solution for (2)*" to "*Solution*".
A-70 – 8.3 #34	In line 3, change "than" to "then" and "then" to "than".
477 – 8.3 #43d	Change "find (*i,f*) in *A*" to "find (*i,j*) in *A*".
477 – 8.3 #43f	In line 3, change the dash to a multiplication dot.
497 – 8.4 #4	Change "*a* = 67 and *b* = 32" to "*a* = 68 and *b* = 33".
513 – 8.5 #3	Change "For all *t*" to "For all *s, t*".

CHAPTER 9

LOCATION	CORRECTION
560 – line 8 from bottom	Change "Then a tmost" to "Then at most".
578 – line 2 from bottom	Replace a period by a comma: change "$S_{3.2}$." to "$S_{3.2}$,".
613 – line 22	Change "$P(B_2 \mid B_1)$ = 1/11" to "$P(B_2 \mid B_1)$ = 4/11".
616 – Theorem 9.9.1	In line 2, change "B_1 " to "B_k".

LOCATION	CORRECTION
A-75 – 9.1 #11b(i)	Change the approximately equal sign to an equal sign.
550 – 9.3 #8d, line 2	Change "has *n* repeated" to "has at least one repeated".
A-79 – 9.3 #7	Change to "*Hint*: The answer is 789,865,128."
A-81 – 9.3 #33a	Change lines 3 and 4 to: "$- N(H\cap D) - N(C\cap D) + N(H\cap C\cap D) = 28 + 26 + 14 - 8 - 4 - 3 + 2 = 55$."
A-81 – 9.3 #33b	Change "100 – 45 = 55" to "100 – 55 = 45".
A-81 – 9.3 #33d	Change line 2 to: "#3 is $N(H\cap D) - N(H\cap C\cap D) = 8 - 2 = 6$."
A-83 – 9.4 #20	Add answer for part b. The length of the repeating section of the decimal representation of 5/20483 is less than or equal to 20,482. The reason is that 20,482 is the number of nonzero remainders that can be obtained when a number is divided by 20,483. Thus, in the long-division process of dividing 5 by 20,483, either some remainder is 0 and the decimal expansion

	terminates, or only nonzero remainders are obtained and at some point within the first 20,482 successive divisions, a nonzero remainder is repeated. At that point the digits in the developing decimal expansion begin to repeat because the sequence of successive remainders repeats those previously obtained.
584 – 9.5 #37	In line 3, change the upper index of the summation to n, change the exponent of 3 from "$4 - k$" to "$n - k$", and change "$- S_{n+1,3}$" to "$= S_{n+1,3}$".
590 – 9.6 #4	In line 2 of the introduction to the exercise and in line 3 of part (c), change "A7b" to "A76".
603 – 9.7 #9	Change "$\binom{2n}{n}$" to "$\binom{2(n+1)}{2n} = (n+1)(2n+1)$".
604 – 9.7 #35	The expression with a and b should be "$a^{m-k}b^{k+1}$".
A-89 – 9.7 #41	Change "$a = -(1/2)$ and $b = 1$" to "$a = 1$ and $b = -(1/2)$".
623 – 9.9 #14	In line 6, change "987%" to "97%".
A-92 – 9.9 #14	Change to: $P(A \mid B_1) = 0.98$ and $P(A^c \mid B_2) = 0.97$. The approximate answer to part (a) becomes 57.6%, and the approximate answer to part (b) is unchanged.

CHAPTER 10

Text

LOCATION	CORRECTION
626 – line 1	Change "Gia and Ira" to "Gia or Ira".
643 – Figure 10.2.1	The blue marking on one of the seven bridges is missing.
643 – lines 10 & 11 from bottom	Change to: "Is it possible to trace this entire graph, starting and ending at the same point, without either lifting your pencil from the paper or crossing an edge more than once?"
648 – Figure 10.2.3	In the explanation for Figure 10.2.3, change "$v_0 v_1 v_2 v_3 v_4 v_5 v_0$" to "$v_0 v_1 v_2 v_3 v_4 v_2 v_5 v_0$".
653 – line 3	Change "Euler path" to "Euler trail".
653 – portrait in margin	This portrait is not of the Sir Wm. Hamilton after whom Hamiltonian circuits are named. You can see a correct portrait at http://en.wikipedia.org/wiki/William_Rowan_Hamilton.
664 – top diagram	There should be two arrows rather than one from v_4 to v_1.
671 – line 4 from bottom	Change "on the previous page" to "shown above".
712 – last line	Change "$\{e, z\}$" to "$\{d, z\}$".
712	In steps 1-5 of the solution for Example 10.7.5, insert the following after "added to $V(T)$": step 1: $D(b)=a$, step 2: $D(c)=a$, step 3: $D(e)=c$, step 4: $D(d)=e$, step 3: $D(z)=d$. To find the shortest path, trace back through the D values from z to a: $D(z)=d$, $D(d)=e$, $D(e)=c$, $D(c)=a$. So the shortest path is a, c, e, d, z.

Exercises

LOCATION	CORRECTION
A-93 – 10.1 #5	Delete the edge between v_2 and v_3.
A-95 – 10.1 #46	In the diagram, change the number annotating vertex b from 2 to 3, and, starting with line 5, change the text to the following: "Observe that vertices c and f do not share an edge with d but do share an edge with each other, which means that color #2 may be used for one but not the other. Choose to color f with color #2 because the degree of f is greater than the degree of c. The remaining uncolored vertices, b, c, and g, are unconnected, and so color #3 may be used for all three."

658 – 10.2 #19-21	In the directions for these exercises, change "path" to "trail".
659 – 10.2 #30	Place a black dot at vertex v_0.
693 – 10.5 #7	The number 7 should be black; only part a has a solution.
693 – 10.5 #13 & #19	Change "nontrivial circuit" to "circuit".
694 – 10.5 #23	Change "nontrivial circuit" to "circuit".
715 – 10.7 #14	Add black dots at c and f.

CHAPTER 11

Text

LOCATION	CORRECTION
729 – line –9	Change "developed in exercises 15 and 50" to "developed for rational numbers in exercises 15 and 50".
729 – Boxes 11.2.1 & 11.2.2	In both boxes, change "For any rational" to "For any real".
740 – Example 11.3.4	Example 11.3.4 should be labeled Example 11.3.1.
742 – Example 11.3.1	Example 11.3.1 should be labeled Example 11.3.2.
742 – Table 11.3.1	In the rightmost column, change "27.8 min" to "27.8 hr".
743 – Example 11.3.2	Example 11.3.2 should be labeled Example 11.3.3.
744 – Example 11.3.3	Example 11.3.3 should be labeled Example 11.3.4.
745 – Algorithm Body	Under the line "$a[j + 1] := a[j]$" insert "$a[j] := x$". Under the line "$j := j – 1$" insert "**else** $j := 0$" Delete the line "$a[j + 1] := x$" (under the line **end while**).
746 – Table	Add 0's in columns 7 and 9 of the bottom row; add 2's in columns 11-13 in the rows above the numbers 7, 6, and 5, respectively. Delete the 7 in row 5, column 9.
746 – Example 11.3.6	In the first line of the solution for Example 11.3.6, delete the word "attempted". In line 6, before the word "Thus", add the sentence, "Also, each incremented value of k is compared to n."
761 – Figure 11.4.6	On the y-axis, the tick mark for 1 should be lowered.
773 – line 12	Change "execpt" to "except".

Exercises

LOCATION	CORRECTION
736 – 11.2 #9	In line 2 change "25" to "33".
738 – 11.2 #49d	Change "$a_1, a_2, ... , a_n$ are real numbers" to "$a_0, a_1... , a_n$ are real numbers with $a_n \neq 0$".
A-112 – 11.3 #22	Add 0's in columns 9 and 13 of the bottom row; add a 1 in row 3, column 6; add a 4 in row 5, column 11; and delete the 8 in row 5, column 9.
A-112 – 11.3 #24	Change to "There are 7 comparisons between values of x and values of $a[j]$: one when $k = 2$, two when $k = 3$, one when $k = 4$, and three when $k = 5$."
749 – 11.3 #26	Change "$5^2 – 5 + 2 = 22$" to "$5^2 + 5 – 2 = 28$".
749 – 11.3 #28-35	In line 10 of Algorithm 11.3.2, after "the value of $a[k]$", insert "if it is less than $a[k]$". Also delete the comma after "**Output**" and before "$a[1]$".
750 – 11.3 #28-35	In line 6, column 1 of Algorithm 11.3.2, change to "If the value of this array element is less than the value of $a[k]$, then its value and the value of $a[k]$ are interchanged."
750 – 11.3 #35d	In line 3, change "an order" to "a worst case order".
764 – 11.4 #41	Change line 2 to "$k_1 n + k_2 n\log n$ for positive integers k_1, k_2, and n"
764 – 11.4 #49c	Change "$n \geq 2$" to "$n \geq 1$".

CHAPTER 12

Exercises

LOCATION	CORRECTION
A-119 – 12.1 #37	Change to "[0 − 9]{3} - [0 − 9]{2} - 3[0 − 9]{2}6".