Appendix C
Answers to Selected Exercises

CHAPTER 2

Section 2-1

2-1. Let a, b denote a part above, below the specification.
$S = \{aaa, aab, aba, abb, baa, bab, bba, bbb\}$

2-7. S is the sample space of 100 possible two-digit integers.

2-9. $S = \{0, 1, 2, \ldots,\}$ in ppb.

2-17. c = connect, b = busy, $S = \{c, bc, bbc, bbbc, bbbbc, \ldots\}$

2-21. (a) $S = \{0, 1, 2, 3, \ldots\}$
(b) S (c) $\{12, 13, 14, 15\}$
(d) $\{0, 1, 2, \ldots, 11\}$ (e) S
(f) $\{0, 1, 2, \ldots, 7\}$ (g) $\varnothing$
(h) $\varnothing$ (i) $\{8, 9, 10, \ldots\}$

2-23. Let d denote a distorted bit and let o denote a bit that is not distorted.

(a) $S = \left\{ \begin{array}{l} dddd, dodd, oddd, oodd, \\ dddo, dodo, oddo, oodo, \\ ddod, dood, odod, oood, \\ ddoo, dooo, odoo, oooo \end{array} \right\}$

(b) No
(c) $\{dddd, dodd, dddo, dodo, ddod, dood, ddoo, dooo\}$

(d) $\{oddd, oodd, oddo, oodo, odod, oood, odoo, oooo\}$
(e) $\{dddd\}$
(f) $\{dddd, dodd, dddo, oddd, ddod, oodd, ddoo\}$

2-25. $2^{12} = 4096$

2-27. (a) $A' \cap B = 10$, $B' = 10$, $A \cup B = 92$

2-29. (a) $A' = \{x \,|\, x \geq 72.5\}$
(b) $B' = \{x \,|\, x \leq 52.5\}$
(c) $A \cap B = \{x \,|\, 52.5 < x < 72.5\}$
(d) $A \cup B = \{x \,|\, x > 0\}$

2-31. Let g denote a good board, m a board with minor defects, and j a board with major defects.
(a) $S = \{gg, gm, gj, mg, mm, mj, jg, jm, jj\}$
(b) $S = \{gg, gm, gj, mg, mm, mj, jg, jm\}$

Section 2-2

2-35. (a) 0.4 (b) 0.8 (c) 0.6
(d) 1 (e) 0.2

2-37. (a) $S = \{1, 2, 3, 4, 5, 6, 7, 8\}$
(b) 2/8 (c) 6/8

2-39. (a) 0.7 (b) 0.8

2-41. (a) 0.25 (b) 0.75

2-43. 5.7×10^{-8}

2-45. (a) 0.86 (b) 0.79 (c) 0.14
(d) 0.70 (e) 0.95 (f) 0.84

2-47. (a) 0.30 (b) 0.77 (c) 0.70
(d) 0.22 (e) 0.85 (f) 0.92

Section 2-3

2-49. (a) 0.7 (b) 0.4 (c) 0.1
(d) 0.2 (e) 0.6 from part (b)
(f) 0.8

2-51. No

2-53. (a) 350/370 (b) 362/370
(c) 358/370 (d) 345/370

2-55. (a) 13/130 (b) No

Section 2-4

2-57. (a) 86/100 (b) $P(B) =$ 79/100 (c) 70/79
(d) 70/86

2-59. (a) 345/357 (b) 5/13

2-61. (a) 0.15 (b) 0.153
(c) 0.72 (d) 0.733
(e) 0.11 (f) 0.76

2-63. (a) 15/40 (b) 14/39
(c) 0.135 (d) 0.599

2-65. (a) $4/499 = 0.0080$
(b) $(5/500)(4/499) = 0.000080$
(c) $(495/500)(494/499) = 0.98$

2-67. (a) 0.813 (b) 0.632
(c) 0.764

Section 2-5

2-71. 0.22
2-73. 0.023
2-75. 0.028
2-77. (a) 0.0225 (b) 0.125
2-79. (a) 0.20 (b) 0.20

Section 2-6

2-81. No
2-83. No
2-85. (a) No (b) 0.733
2-87. (a) 0.59 (b) 0.328 (c) 0.41
2-89. (a) 0.00003 (b) 0.00024
(c) 0.00107
2-91. 0.9702
2-93. (a) No (b) Yes

Section 2-7

2-95. 0.003
2-97. (a) 0.615 (b) 0.618
(c) 0.052
2-99. (a) 0.9847 (b) 0.1184

Supplemental

2-101. The sample space $S = \{A, A'D_1,$ $A'D_2, A'D_3, A'D_4, A'D_5\}$
2-103. (a) 0.19 (b) 0.15 (c) 0.99
(d) 0.80 (e) 0.158
2-105. (a) No (b) No (c) 40/240
(d) 200/240 (e) 234/400
(f) 1
2-107. (a) 0.282 (b) 0.718
2-109. 0.996
2-111. (a) 0.0037 (b) 0.811
2-113. (a) 0.0778 (b) 0.00108
(c) 0.947
2-115. (a) 0.9764 (b) 0.680
2-117. (a) 0.207 (b) 0.625 (c) 0.6
2-119. (a) 0.453 (b) 0.261
(c) 0.881 (d) 0.547
(e) 0.783 (f) 0.687
2-121. 1.58×10^{-7}

CHAPTER 3

Section 3-1

3-1. $\{0, 1, 2, \ldots, 1000\}$
3-3. $\{0, 1, 2, \ldots, 99999\}$

Section 3-2

3-13. $f_X(0) = 1/3, f_X(1.5) = 1/3,$ $f_X(2) = 1/6, f_X(3) = 1/6$
3-15. (a) 1 (b) 7/8 (c) $^3/_4$
(d) $^1/_2$
3-17. (a) 9/25 (b) 4/25
(c) 12/25 (d) 1
3-19. $P(X = 10$ million$) = 0.3,$ $P(X = 5$ million$) = 0.6,$ $P(X = 1$ million$) = 0.1$
3-21. $P(X = 0) = 8 \times 10^{-6},$ $P(X = 1) = 0.0012,$ $P(X = 2) = 0.0576,$ $P(X = 3) = 0.9412$
3-23. $P(X = 15$ million$) = 0.6,$ $P(X = 5$ million$) = 0.3,$ $P(X = -0.5$ million$) = 0.1$
3-25. $P(X = 0) = 0.00001,$ $P(X = 1) = 0.00167,$ $P(X = 2) = 0.07663,$ $P(X = 3) = 0.92169$

Section 3-3

3-27. (a) 7/8 (b) 1 (c) $^3/_4$
(d) 3/8
3-29. $F(x) = 0$ for $x < 1$ million; 0.1 for 1 million $\leq x < 5$ million; 0.7 for 5 million $\leq x < 10$ million; 1 for 10 million $\leq x$
3-31. $F(x) = 0$ for $x < 0$; 0.008 for $0 \leq x < 1$; 0.104 for $1 \leq x < 2$; 0.488 for $2 \leq x < 3$; 1 for $3 \leq x$
3-33. (a) 1 (b) 0.5 (c) 0.5
(d) 0.5
3-35. (a) 1 (b) 0.75 (c) 0.25
(d) 0.25 (e) 0 (f) 0

Section 3-4

3-37. $E(X) = 2, V(X) = 2$
3-39. $E(X) = 0, V(X) = 1.5$
3-41. $E(X) = 6.1$ million, $V(X) = 7.89$ million^2
3-43. $E(X) = 2.4, V(X) = 0.48$
3-45. $x = 24$

Section 3-5

3-47. $E(X) = 2, V(X) = 0.667$
3-49. $E(X) = 0.17, V(X) = 0.0002$
3-51. $E(X) = 590.45, V(X) = 0.0825$

Section 3-6

3-57. (a) 0.2461 (b) 0.0547
(c) 0.0107 (d) 0.3223

3-59. (a) 2.4×10^{-8} (b) 0.99989
(c) 9.91×10^{-18}
(d) 1.138×10^{-4}
3-61. $F(x) = 0$ for $x < 0$; 0.4219 for $0 \leq x < 1$; 0.8438 for $1 \leq x < 2$; 0.9844 for $2 \leq x < 3$; 1 for $3 \leq x$
3-63. (a) 0.3681 (b) 0.6323
(c) 0.9198 (d) $E(X) = 1,$ $V(X) = 0.999$
3-65. (a) $n = 50, p = 0.1$
(b) 0.1117 (c) 4.51×10^{-48}
3-67. (a) 0.9961 (b) 0.9886
3-69. (a) 0 (b) 0.2137

Section 3-7

3-71. (a) 0.5 (b) 0.0625
(c) 0.0039 (d) 0.75 (e) 0.25
3-73. (a) 0.0064 (b) 0.9984
(c) 0.008
3-75. (a) 0.0167 (b) 0.9224 (c) 50
3-77. (a) 3.91×10^{-19} (b) 200
(c) 2.56×10^{18}
3-79. (a) 5 (b) 5
3-81. (a) 20 (b) 0.0436
(c) 0.0459 (d) 0.0411 (e) 19
3-83. (a) 3000 (b) 1431.18

Section 3-8

3-87. (a) 0.4623 (b) 0.0002
(c) 0.9866 (d) $E(X) = 0.8,$ $V(X) = 0.539$
3-89. $F(X) = 0$ for $x < 0$; 1/6 for $0 \leq x < 1$; 2/3 for $1 \leq x < 2$; 29/30 for $2 \leq x < 3$; 1 for $3 \leq x$
3-91. (a) 0.1201 (b) 0.8523
3-93. (a) 0.7069 (b) 0.0607
(c) 0.2811

Section 3-9

3-97. (a) 0.0183 (b) 0.2381
(c) 0.1954 (d) 0.0298
3-99. $E(X) = 2.996, \quad V(X) = 2.996$
3-101. (a) 0.0045 (b) 0.3679
(c) 0.1353 (d) 0.2642
3-103. (a) 4.54×10^{-5} (b) 0.6321
3-105. (a) 0.6065 (b) 8.9×10^{-5}
(c) 0.00146

Supplemental

3-107. 0.3714
3-109. (a) 0.0117 (b) 1.3333
3-111. (a) 0.1755 (b) 0.0858
(c) 0.2873
3-113. 0.9810

3-115.

x	2	3	4	5	6
$f(x)$	0.0025	0.01	0.03	0.065	0.13

x	7	8	9	10
$f(x)$	0.18	0.2225	0.2	0.16

3-117. 299
3-119. (a) 4.1×10^{-5} (b) 10
(c) 0.9995
3-121. (a) 0.6   (b) 0.8   (c) 0.7
(d) 3.9   (e) 3.09
3-123. (a) 0.2408   (b) 0.4913
3-125. (a) 0.3233   (b) 0.0916
3-127. 0.0738
3-129. (a) 0.3679   (b) 50.51
(c) 0.9234

CHAPTER 4

Section 4-2
4-1. (a) 0.3670   (b) 0.2858   (c) 0
(d) 0.9817   (e) 0.0498
4-3. (a) 0.4375   (b) 0.7969
(c) 0.5625   (d) 0.7031
(e) 0.5
4-5. (a) 0.5   (b) 0.4375   (c) 0.125
(d) 0   (e) 1   (f) 0.9655
4-7. (a) 0.5   (b) 49.8
4-9. (a) 0.10   (b) 2.5

Section 4-3
4-11. (a) 0.56   (b) 0.7   (c) 0   (d) 0
4-13. $1 - e^{-x}$ for $x > 0$
4-15. $1 - e^{-(x-4)}$ for $x > 4$
4-17. (a) $1.25x - 93.25$ for
$74.6 < x < 75.4$ (b) 0.5
4-21. $F(x) = 0$ for $x < 0$; $0.25x^2$ for
$0 \leq x < 2$; 1 for $x \leq 2$

Section 4-4
4-23. $E(X) = 2.6667, V(X) = 0.8889$
4-25. $E(X) = 4.083, V(X) = 0.3291$
4-27. (a) $E(X) = 109.39$ μm,
$V(X) = 33.19$ μm^2
(b) \$54.70
4-29. (a) $E(X) = 5.1$ mm, $V(X) =$
0.01 mm^2 (b) 0.3679

Section 4-5
4-31. (a) $E(X) = 3.5, V(X) = 1.33$,
$\sigma_X = 1.155$ (b) 0.25
4-33. (a) $E(X) = 50, V(X) = 0.0208$,
$\sigma_X = 0.144$ (b) $F(x) = 2x$
-99.5 for $49.75 < x < 50.25$
(c) 0.7

4-35. (a) $E(X) = 1.85$ min, $V(X) =$
0.0408 min^2 (b) 0.7143
(c) $F(x) = (x - 1.5)/0.7$ for
$1.5 < x < 2.2$
4-37. (b) 0.25   (c) 0.2140
(d) $E(X) = 0.2100$ μm,
$V(X) = 0.00000833$ μm^2

Section 4-6
4-39. (a) 0.90658   (b) 0.99865
(c) 0.07353   (d) 0.98422
(e) 0.95116
4-41. (a) 1.28   (b) 0   (c) 1.28
(d) -1.28 (e) 1.33
4-43. (a) 0.93319   (b) 0.69146
(c) 0.9545   (d) 0.00135
(e) 0.15866
4-45. (a) 0.93319   (b) 0.89435
(c) 0.38292   (d) 0.80128
(e) 0.54674
4-47. (a) 0.99379   (b) 0.13591
(c) 5835
4-49. (a) 0.0082   (b) 0.72109
(c) 0.564
4-51. (a) 0.00135   (b) 0.15866
(c) 71.6 min
4-53. (a) 0.02275   (b) 0.47725
(c) 0.336
4-55. (a) 0.15866   (b) 90.0
(c) 99.73%
4-57. (a) 0.15245   (b) 125.6
4-59. (a) 0.06681   (b) 0.86638
(c) 0.000214

Section 4-7
4-61. (a) 0.075   (b) 0.85
4-63. (a) 0.129   (b) 0.488
4-65. 0.013
4-67. 0.966
4-71. (b) 330   (c) 0.0089

Section 4-9
4-73. (a) 0.3679   (b) 0.1353
(c) 0.0498   (d) 29.96
4-75. (a) 0.333 min   (b) 0.333 min
(c) 0.9986
4-77. (a) 0.1353   (b) 0.4866
(c) 0.2031   (d) 34.54
4-79. (a) 0.0498   (b) 0.8775
4-81. (a) 0.0025   (b) 0.6321
4-83. (a) 0.1353   (b) 0.2707   (c) 5
4-85. (a) 0.2212   (b) 0.2865
(c) 0.2212
4-87. 0.8488

4-93. (a) 5   (b) 0.1353   (c) No
(d) 11.51

Section 4-10
4-97. (a) 0.1755   (b) 0.2643
4-99. (a) 50,000   (b) 0.677
4-101. (a) 500,000   (b) 223607
(c) 0.0803
4-103. (a) 0.1429   (b) 0.1847
4-105. (a) 120   (b) 1.32934
(c) 11.6317

Section 4-11
4-109. (a) 12,000   (b) 3.61×10^{10}
4-111. (a) 0.5273   (b) 8862.3
(c) 0.00166
4-113. (a) 0.275   (b) 0.685
4-115. (a) 443.11   (b) 53650.5
(c) 0.2212

Section 4-12
4-117. (a) 0.9332   (b) 20952.2
(c) $E(X) = 13359.7$,
$V(X) = 1.45 \times 10^{12}$
4-119. (a) 0.983   (b) 0.45
4-121. $\theta = 3.45, \omega^2 = 2.25$

Supplemental
4-125. $0.25x^2 - x + 1$ for $2 < x < 4$
4-127. (a) 0.3935   (b) 0.3834
(c) 23.03
4-129. (a) 0.423   (b) 50
4-133. (a) $\theta = 3.43, \omega^2 = 0.96$
(b) 0.946
4-135. (a) 0.6915   (b) 0.683
(c) 1.86
4-137. (a) 0.0062   (b) 0.0124
(c) 5.33
4-139. 0.0008 to 0.0032
4-141. $\mu = 11,398$
4-143. (a) 0.5633   (b) 737.5
4-145. (a) 0.984   (b) 0.834

CHAPTER 5

Section 5-1
5-1. $f(x, y) \geq 0$, $\sum f(x, y) = 1$
5-3. $E(X) = 1.8125$,
$E(Y) = 2.875$
5-5. $c = 1/36$
5-7. $E(X) = 2.167$, $V(X) = 0.639$,
$E(Y) = 2.167$, $V(Y) = 0.639$

5-9. $f(x, y) \geq 0, \ \sum f(x, y) = 1$
5-11. $E(X) = 1/8, E(Y) = 1/4$
5-13. $X \geq 0, Y \geq 0$ and $X + Y \leq 4$
5-15. (b) $f_X(0) = 0.2338, f_X(1) = 0.4188, f_X(2) = 0.2679, f_X(3) = 0.0725, f_X(4) = 0.0070$
  (c) $E(X) = 1.2$
  (d) $f_{Y|3}(0) = 0.857,$
    $f_{Y|3}(1) = 0.143,$
  (e) $E(Y \mid X = 3) = 0.143$

Section 5-2

5-17. (a) 0.5 (b) 0.35 (c) 0.5
  (d) 0.8 (e) 1.5
5-19. $P(X = 1 \mid Y = 1, Z = 2) = 0.4,$
  $P(X = 2 \mid Y = 1, Z = 2) = 0.6$
5-21. (a) 0 (b) 0.072 (c) 0.736
  (d) 1
5-23. (a) $x \geq 0, y \geq 0, z \geq 0,$
    $x + y + z = 4$
  (b) No
5-25. (a) 0.1758 (b) 0.2198
  (c) $E(X) = 1.067,$
    $V(X) = 0.6146$
5-27. (a) Yes (b) 0.1944
  (c) 0.0001
5-29. (a) 0.7347 (b) 0
  (c) $P(X = 0 \mid Y = 2) = 0.0204,$
    $P(X = 1 \mid Y = 2) = 0.2449,$
    $P(X = 2 \mid Y = 2) = 0.7347$
  (c) $E(X \mid Y = 2) = 1.7142$
5-31. (a) binomial $p = 0.03, n = 3$
    $E(X) = 0.03, V(X) = 0.0297$
  (b) $P(X = 0 \mid Y = 2) = 0.98958,$
    $P(X = 1 \mid Y = 2) = 0.01042$
  (c) $E(X \mid Y = 2) = 0.01042,$
    $V(X \mid Y = 2) = 0.01031$

Section 5-3

5-35. (a) 0.4444 (b) 0.6944
  (c) 0.5833 (d) 0.3733 (e) 2
  (f) 0
5-37. 1/24
5-39. (a) $(2x + 1)/12$ for $0 < x < 3$
  (b) $(y + 1)/6$ for $1 < y < 3$
  (c) 2.111
  (d) 0.4167
  (e) $(2 + x)/6$ for $0 < x < 2$
5-43. 10
5-45. (a) $10(e^{-2x} - e^{-5x})/3$ for $0 < x$
  (b) $3.157e^{-3y}$ for $0 < y < 1$
  (c) 0.089 (d) $2e^{-2x+4}$ for $2 < x$

5-49. 2/15
5-51. (a) $(x + 1)/7.5$ for $0 < x < 1,$
    $2/7.5$ for $1 < x < 4$
  (b) 0.5 for $0 < y < 2$
  (c) 1 (d) 0.25
5-53. (a) 0.0439, 0.0019
  (b) 0.065

Section 5-4

5-55. (a) 0.25 (b) 0.0625 (c) 1
  (d) 1 (e) 2/3
5-57. (a) $2x$ for $0 < x < 1$
  (b) 0.25
5-61. 6
5-63. (a) $3(x - 1)^2$ for $0 < x < 1$
  (b) $6(1 - x - y)$ for $0 < x,$
    $0 < y$ and $x + y < 1$
  (c) 1 for $x = 0$
  (d) $4(1 - 2x)$ for $x < 0.5$
5-65. (a) 0.032 (b) 0.0267

Section 5-5

5-67. $\sigma_{XY} = 0.703, \rho_{XY} = 0.885$
5-69. $c = 1/36, \sigma_{XY} = -1/36,$
  $\rho_{XY} = -0.0435$
5-71. $\sigma_{XY} = -1/3, \rho_{XY} = -1/2$
5-73. $c = 9.5, \sigma_{XY} = 1.852,$
  $\rho_{XY} = 0.928$
5-75. X and Y are independent and
  $\sigma_{XY} = \rho_{XY} = 0$

Section 5-6

5-81. 0.827

Section 5-7

5-87. (a) 30 (b) 97 (c) 0.5
  (d) 0.846
5-89. (a) $E(T) = 4, \sigma_T = 0.1414$
  (b) 0.017
5-91. (a) $E(D) = 1/8, \sigma_D = 0.140$
  (b) 0.187 (c) 0.187
5-93. (a) 0.05 (b) 0.023
  (c) 12.129
  (d) 0.388 (e) 136
5-95. (a) 0.023 (b) 4558

Supplemental

5-97. (a) 3/8 (b) 3/4 (c) 3/4
  (d) 3/8
  (e) $E(X) = 7/8, V(X) = 39/64, E(Y) = 7/8,$
    $V(Y) = 39/64$

5-99. (a) 0.0631 (b) 0.122
  (c) $E(X) = 2, V(X) = 1.8$
  (d) $f_{X|19}(0) = 0.667,$
    $f_{X|19}(1) = 0.333$
  (e) 1/3
5-103. (b) 1/3 (c) No
5-105. (a) 0.0093 (b) 0.5787
  (c) 0.75 (d) 0.2199
  (e) 2.25 (f) 1.3333
5-107. (a) 1/2 (b) 1/4 (c) $1/\pi$ for
    $x^2 + y^2 \leq 1$
  (d) $2\sqrt{1 - x^2}/\pi$ for $-1 < x < 1$
5-109. 3/4
5-111. (a) 0.085 (b) Bin(10, 0.3)
  (c) 3
5-113. (a) 0.499 (b) 0.5
5-115. (a) 0.057 (b) 0.057
5-119. (a) $E(T) = 1.5, V(T) = 0.078$
  (b) $\cong 0$
  (c) $E(P) = 4, V(P) = 0.568$
5-121. $\mu = 5, \sigma = \sqrt{3}$

CHAPTER 6

Section 6-1

6-1. $\bar{x} = 74.0044, s = 0.00473$
6-3. $\bar{x} = 7068.1, s = 226.5$
6-5. $\bar{x} = 43.975, s = 12.294$
6-7. $\mu = 5.44$
6-11. (a) $\bar{x} = 7.184$
  (b) $s = 0.02066$
6-13. (a) $\bar{x} = 65.85, s = 12.16$
  (c) $\bar{x} = 66.86, s = 10.74$

Section 6-3

6-19.

Variable	N	Median	Q1	Q3
cycles	70	1436.5	1097.8	1735.0

6-21.

Variable	N	Median	Q1	Q3
yield	90	89.250	86.100	93.125

6-25. $\bar{x} = 260.7, s = 13.03,$ and
  $\tilde{x} = 261.15$
6-27. (b) $\bar{x} = 89, s = 2.8,$ and
    $\tilde{x} = 90$ (c) 22/40

Section 6-5

6-43. (a) $\bar{x} = 4.0$ (b) $s^2 = 0.867,$
    $s = 0.931$
6-45. (a) $\bar{x} = 952.44, s^2 = 9.55,$
    $s = 3.09$
  (b) $\tilde{x} = 953,$ largest value can
    increase by any amount

6-47. (a) $\bar{x} = 48.125$, $\tilde{x} = 49$
(b) $s^2 = 7.246$, $s = 2.692$

Supplemental

6-73. (a) $\bar{x} = 65.083$
(b) $s^2 = 1.86869$, $s = 1.367$

6-75. (a) Sample 1: range = 4;
Sample 2: range = 4
(b) Sample 1: $s = 1.604$;
Sample 2: $s = 1.852$

6-79. (b) $\bar{x} = 9.325$, $s = 4.48586$

CHAPTER 7

Section 7-2

7-1. Estimator 1

7-3. Estimator 2

7-5. 2.5

7-7. Estimator 3 is most efficient; estimator 2 is the best "unbiased" estimator.

7-11. (a) 75.427   (b) 75.1
(c) $\sigma^2 = 2.214$, $\sigma = 1.488$
(d) 0.292   (e) 0.0385

7-13. (a) Yes   (b) $\dfrac{1}{\sqrt{2}}\,\sigma$

7-15. (b) $se = \sqrt{\dfrac{\sigma_1^2}{n_1} + \dfrac{\sigma_2^2}{n_2}}$

7-17. (b)
$$se(\hat{\mu}) = \sigma_1 \sqrt{\dfrac{\alpha^2 n_2 + (1-\alpha)^2 a n_1}{n_1 n_2}}$$
(c) $\alpha = \dfrac{a n_1}{n_2 + a n_1}$ (d) 0.10

Section 7-3

7-31. (a) 423.33, 82.4464

Section 7-5

7-33. 0.8385

7-35. 0.43055

7-37. 0.3472

7-39. 12

7-41. 0.2313

7-43. (a) 0.5885
(b) 0.1759

7-45. 0.983

Supplemental

7-49. $\bar{X}_1 - \bar{X}_2 \sim N(-5, 0.2233)$

7-51. 0.8664

7-53. 1 (approximately)

7-55. 0 (approximately)

CHAPTER 8

Section 8-2

8-1. 97.93%, 99.36%, and 96.78%

8-3. (a) 1.29   (b) 1.65   (c) 2.33

8-5. 3

8-7. (a) Longer   (b) No
(c) Yes

8-9. (89.471, 91.489)

8-11. (a) (74.0353, 74.0367)
(b) (74.0355, ∞)

8-13. (a) (3232.11, 3267.89)
(b) (3226.5, 3273.5)

8-15. 267

8-17. 4

Section 8-3

8-19. $t_{0.025,15} = 2.131$, $t_{0.05,10} = 1.812$,
$t_{0.10,20} = 1.325$, $t_{0.005,25} = 2.787$,
$t_{0.001,30} = 3.385$

8-21. (a) $t_{0.05,14} = 1.761$
(b) $t_{0.01,19} = 2.359$
(c) $t_{0.001,24} = 3.467$

8-23. (1.108, ∞)

8-25. (a) Yes   (b) (16.455, 17.505)

8-27. (a) Yes   (b) (8.216, 8.244)

8-29. (4.023, ∞)

8-31. (1.093, 1.106)

Section 8-4

8-33. $\chi^2_{0.05,10} = 18.31$,
$\chi^2_{0.025,15} = 27.49$,
$\chi^2_{0.01,12} = 26.22$,
$\chi^2_{0.005,25} = 46.93$,
$\chi^2_{0.95,20} = 10.85$,
$\chi^2_{0.99,18} = 7.01$,
$\chi^2_{0.995,16} = 5.14$

8-35. $0.00003075 < \sigma^2$

8-37. $7,975,727.09 < \sigma^2$

8-39. $0.31 < \sigma < 0.46$

8-41. $3.8 \le \sigma$

Section 8-5

8-43. 622

8-45. 666

8-47. 5759

Section 8-6

8-49. $52131.1 \le X_{n+1} \le 68148.3$

8-51. $263.5 \le X_{n+1} \le 370.9$

8-53. $2193.5 \le X_{n+1} \le 2326.5$

8-55. $3.19 \le X_{n+1} \le 4.19$

8-57. $2.56 \le X_{n+1} \le 3.22$

8-59. $228.1 \le X_{n+1} \le 235.2$

Section 8-7

8-61. (0.408, 2.092)

8-63. (15.14, 18.82)

8-65. (8.16, 8.30)

8-67. (3.91, ∞)

8-69. (1.06, 1.14)

Supplemental

8-71. (a) $0.1 \le P\text{-value} \le 0.25$
(b) $0.05 \le P\text{-value} \le 0.1$
(c) $P\text{-value} = 0.00539$

8-75. (a) 40   (b) 23

8-77. $2178.51 \le X_{n+1} \le 2341.49$

8-79. (a) Yes
(b) $0.618 \le \mu \le 0.630$
(c) $0.588 \le X_{n+1} \le 0.660$
(d) (0.583, 0.665)

8-81. (a) Yes
(b) $2.270 \le \mu \le 4.260$
(c) $-1.297 \le X_{n+1} \le 7.827$
(d) (−3.113, 10.363)

8-83. (a) $0.0021 \le p \le 0.0088$
(b) Yes

8-85. (a) $0.210 \le p \le 0.274$
(b) $0.204 \le p \le 0.280$

CHAPTER 9

Section 9-1

9-1. (a) Yes   (b) No   (c) No
(d) No   (e) No

9-3. (a) 0   (b) 0.02275

9-5. 11.5875

9-7. (a) 0.09296   (b) 0.04648
(c) 0.00005

9-9. (a) Reject H_0 (b) 0.00889

9-11. (a) 182.9   (b) 0.00776

9-13. (a) 0.0164   (b) 0.21186

9-17. (a) 0.08535   (b) 0

9-19. (a) 0.29372   (b) 0.25721

Section 9-2

9-21. (a) $z_0 = 0.36$, do not reject H_0
(b) $P\text{-value} = 0.71884$ (c) 5
(d) 0.68054   (e) (87.85, 93.11)

9-23. (a) $z_0 = -1.69$, do not reject H_0
(b) 0.091028   (c) 0   (d) 1

9-25. (a) $z_0 = -14.43$, reject H_0
(b) 0   (c) (3232.11, 3267.89)

9-27. (a) $z_0 = 1.55$, do not reject H_0
(b) 0.02938   (c) 1
(d) (99.888, ∞)

9-29. (a) $z_0 = 1.77$, reject H_0 (b) 1
(c) 35   (d) (4.003, ∞)

Section 9-3

9-31. (a) $t_0 = -3.48$, reject H_0,
        P-value $= 0.002$
    (b) 1   (c) 35
    (d) (98.065, 98.463)
    (e) Yes

9-33. (a) $t_0 = -1.46$, do not reject
        H_0, P-value $= 0.156$
    (b) Yes   (c) 0.85   (d) 51
    (e) (129.406, 130.100)

9-35. $t_0 = 4.47$, reject H_0,
    P-value < 0.0005

9-37. (a) $t_0 = -5.35$, do not reject H_0
    (b) P-value > 0.4
    (c) 0.75   (d) 38

9-39. (a) $t_0 = 2.806$, reject H_0
    (b) P-value $= 0.004$ (c) 1
    (d) 3

9-41. (a) $t_0 = 3.018$, reject H_0
    (b) P-value $= 0.0038$ (c) 0.8
    (d) 38

Section 9-4

9-43. (a) $\chi_0^2 = 8.96$, do not reject H_0
    (b) $0.5 < P$-value < 0.9
    (c) 50

9-45. (a) $\chi_0^2 = 4984.83$, reject H_0
    (b) P-value < 0.005

9-47. (a) $\chi_0^2 = 109.52$, reject H_0
    (b) $0.31 < \sigma < 0.46$

9-49. 30

Section 9-5

9-51. 0.639, 118

9-53. (a) $z_0 = -0.53$, do not reject H_0
    (b) P-value $= 0.29806$

9-55. (a) $z_0 = 0.452$, do not reject H_0
    (b) P-value $= 0.67364$

9-57. (a) $\alpha = 0.0853$ (b) $\beta \cong 0$

Section 9-7

9-59. (a) $\chi_0^2 = 7.2$, do not reject H_0
    (b) $0.05 < P$-value < 0.10

9-61. (a) $\chi_0^2 = 1.72$, do not reject H_0
    (b) $0.5 < P$-value < 0.9

9-63. (a) $\chi_0^2 = 1.053$, do not reject H_0
    (b) $0.1 < P$-value < 0.5

Section 9-8

9-65. (a) $\chi_0^2 = 11.65$, do not reject H_0
    (b) $0.05 < P$-value < 0.10

9-67. (a) $\chi_0^2 = 25.55$, reject H_0
    (b) P-value < 0.005

9-69. (a) $\chi_0^2 = 10.71$, do not reject H_0
    (b) $0.05 < P$-value < 0.10

Supplemental

9-71. (a) $p(1 - p)/50$
    (b) $p(1 - p)/80$
    (c) $p(1 - p)/100$

9-73. (a) $\beta = 0.564$
    (b) $\beta = 0.161$
    (c) $\beta = 0.116$

9-75. (a) 0.61026   (b) 0.995
    (c) 0.9988

9-79. (a) $\chi_0^2 = 5.546$, reject H_0
    (b) $0.01 < P$-value < 0.025

9-81. (a) $\chi_0^2 = 1.75$, do not reject H_0

9-83. (a) $\chi_0^2 = 17.929$, reject H_0
    (b) P-value $= 0.0123$

9-85. (a) $\chi_0^2 = 63.36$, reject H_0

9-87. (a) $z_0 = -7.32$, reject H_0
    (b) P-value $\cong 0$
    (c) $\chi_0^2 = 12.0$, reject H_0

9-89. (b) $t_0 = 1.608$, do not reject H_0
    (c) $0.1 < P$-value < 0.2

CHAPTER 10

Section 10-2

10-1. (a) Yes, cannot reject H_0
    (b) P-value $= 0.3222$
    (c) 0.9967
    (d) $(-0.0098, 0.00298)$
    (e) 9

10-3. 1, Yes

10-5. (a) (0.0987, 0.2813)
    (b) (0.0812, 0.299)
    (c) $(-\infty, 0.2813)$

10-7. (a) $(-3.684, -2.116)$
    (b) $z_0 = -7.254$ reject H_0
    (c) P-value $\cong 0$

10-9. 11

10-11. (a) $(-5.83, -0.57)$ (b) Yes

10-13. $z_0 = -2.385$, reject H_0

10-15. Yes

Section 10-3

10-17. (a) $t_0 = 0.230$, do not reject H_0
    (b) P-value > 0.80
    (c) $(-0.394, 0.494)$

10-19. (a) $t_0 = -3.11$, reject H_0
    (b) $(-5.688, -0.3122)$

10-21. (a) $t_0 = -2.83$, reject H_0
    (b) $0.010 < P$-value < 0.020
    (c) (0.111, 0.749)

10-23. (17.235, 44.765)

10-25. $t_0 = -5.499$, P-value < 0.0010

10-27. (a) $t_0 = 3.03$, reject H_0
    (b) $0.005 < P$-value < 0.010
    (c) $t_0 = 3.03$, reject H_0

10-29. $(-14.34, 21.94)$

10-31. (b) $t_0 = 2.558$, reject H_0
    (c) P-value $\cong 0.020$
    (d) 0.05   (e) $n = 51$
    (f) (1.86, 18.94)

Section 10-4

10-33. (0.1694, 0.3778)

10-35. $t_0 = 0.357$, cannot reject H_0

10-37. $(-727.46, 2464.21)$

10-39. $t_0 = 5.465$, reject H_0

10-41. $t_0 = 8.387$, reject H_0

10-43. $t_0 = 3.45$, reject H_0

Section 10-5

10-45. (a) 1.59   (b) 2.28   (c) 2.64
    (d) 0.529   (e) 0.524
    (f) 0.311

10-47. $f_0 = 0.657$, cannot reject H_0

10-49. No

10-51. (a) (0.08775, 3.594)
    (b) (0.0585, 5.3)
    (c) $(0.137, \infty)$

10-53. $f_0 = 0.297$, cannot reject H_0

10-55. $f_0 = 0.2575$, cannot reject H_0

10-57. (0.3369, 2.640)

10-59. $f_0 = 0.640$, cannot reject H_0

Section 10-6

10-61. $z_0 = 1.49$, cannot reject H_0

10-63. (a) 0.81859   (b) 383

10-65. (a) $z_0 = 3.42$, reject H_0,
        P-value $= 0.00062$

10-67. (0.0434, 0.1616)

Supplemental

10-69. (1.40, 8.36)

10-71. (a) $t_0 = 2.554$, reject H_0
    (b) $t_0 = 2.554$, cannot reject H_0
    (c) $t_0 = -1.986$, cannot reject H_0
    (d) $t_0 = -1.986$, cannot
        reject H_0

10-73. (a) $z_0 = 6.55$, reject H_0
    (b) $z_0 = 6.55$, reject H_0

10-75. (a) $(-0.0335, 0.0329)$
    (b) $(-0.0282, 0.0276)$
    (c) $(-0.0238, 0.0232)$,
        $(-0.0203, 0.0200)$

10-79. 60

10-81. 26

10-83. (a) No   (b) Yes
    (d) (18.124, 294.35)

10-85. (b) $t_0 = -6.06$, reject H_0

10-87. (b) $t_0 = -0.512$, cannot
        reject H_0 (c) 16

10-89. (b) $t_0 = -2.74$, reject H_0
 (c) 0.8   (d) 26

CHAPTER 11

Section 11-2

11-1. (a) $\hat{\beta}_0 = 48.013$, $\hat{\beta}_1 = -2.330$
 (b) 37.99   (c) 39.39   (d) 6.71
11-3. (a) $\hat{\beta}_0 = 0.4631476$,
  $\hat{\beta}_1 = 0.0074902$
 (b) $\hat{\beta}_1 = 0.00749$
11-5. (a) $\hat{\beta}_0 = 13.3202$,
  $\hat{\beta}_1 = 3.32437$,
  $\hat{\sigma}^2 = 8.76775$
 (b) 38.253   (c) -2.0273
11-7. (a) $\hat{\beta}_0 = 33.5348$,
  $\hat{\beta}_1 = -0.0353971$,
  $\hat{\sigma}^2 = 13.392$
 (b) 28.226   (c) 1.50048
11-9. (b) $\hat{\beta}_0 = -9.8131$,
  $\hat{\beta}_1 = 0.171484$,
  $\hat{\sigma}^2 = 1.9818$
 (c) 4.76301
11-11. (b) $\hat{\beta}_0 = 0.470467$,
  $\hat{\beta}_1 = 20.5673$,
  $\hat{\sigma}^2 = 13.81$
 (c) 21.038   (d) 1.6629
11-17. $\hat{\beta}_0 = 0$, $\hat{\beta}_1 = 21.031461$

Section 11-5

11-19. (a) $f_0 = 73.95$, P-value $=$
  0.000001, reject H_0
 (b) $se(\hat{\beta}_1) = 0.0004839$,
  $se(\hat{\beta}_0) = 0.04091$
11-21. (a) $t_0 = 8.518$, reject H_0
 (b) $f_0 = 72.5563$, reject H_0
 (c) $se(\hat{\beta}_1) = 0.3902$,
  $se(\hat{\beta}_0) = 2.5717$
 (d) $t_0 = 5.2774$, reject H_0
11-23. (a) $f_0 = 4.53158$, do not reject
  H_0, P-value $= 0.04734$
 (b) $se(\hat{\beta}_1) = 0.0166281$,
  $se(\hat{\beta}_0) = 2.61396$
 (c) $t_0 = 0.87803$, P-value $=$
  0.804251, do not reject H_0
 (d) $t_0 = 12.8291$, P-value $\cong 0$,
  reject H_0
11-25. (a) $f_0 = 44.6567$, reject H_0
  P-value $= 0.000003$
 (b) $se(\hat{\beta}_1) = 0.0256613$,
  $se(\hat{\beta}_0) = 2.13526$
 (c) $t_0 = -4.59573$, reject H_0,
  P-value $= 0.00022$
11-27. (a) $f_0 = 155$, reject H_0
  P-value < 0.00001

 (b) $se(\hat{\beta}_1) = 0.0256613$,
  $se(\hat{\beta}_0) = 2.13526$
 (c) $t_0 = -4.59573$, reject H_0
  P-value $= 0.00022$
 (d) $t_0 = 57.8957$, reject H_0
  P-value < 0.00001
 (e) $t_0 = 2.7651$, reject H_0
  P-value $= 0.0064$

Section 11-6 and Section 11-7

11-31. (a) $(-2.9175, -1.7421)$
 (b) $(46.7145, 49.3114)$
 (c) $(41.3293, 43.0477)$
 (d) $(38.4289, 46.1281)$
11-33. (a) $(-0.00961, -0.00444)$
 (b) $(16.2448, 27.3318)$
 (c) $(7.91433, 10.37167)$
 (d) $(4.07214, 14.21386)$
11-35. (a) $(9.10130, 9.31543)$
 (b) $(-11.6219, -1.04911)$
 (c) $(498.72024, 501.52776)$
 (d) $(495.57344, 504.67456)$
11-37. (a) $(0.03689, 0.010183)$
 (b) $(-47.0877, 14.0691)$
 (c) $(44.0897, 49,1185)$
 (d) $(37.8298, 55.3784)$
11-39. (a) $(201.552, 226.590)$
 (b) $(-4.67015, -2.346960)$
 (c) $(111.8339, 145.7941)$
11-41. (a) $(-43.1964, -30.7272)$
 (b) $(2530.09, 2720.68)$
 (c) $(1823.7833, 1948.5247)$
 (d) $(1668.9013, 2103.4067)$

Section 11-8

11-43. (d) $R^2 \cong 76.73\%$
11-45. (a) $R^2 = 20.1121\%$
 (c) Yes
11-47. (a) $R^2 = 71.27\%$
11-49. (a) $R^2 = 85.22\%$

Section 11-10

11-55. (a) $\hat{\beta}_0 = -0.0280411$,
  $\hat{\beta}_1 = 0.990987$
 (b) $f_0 = 79.838$, reject H_0
 (c) 0.903   (d) $t_0 = 8.9345$,
  reject H_0
 (e) $z_0 = 3.879$, reject H_0
 (f) $(0.7677, 0.9615)$
11-57. (a) $r = -0.738027$
 (b) $t_0 = -5.577$, reject H_0,
  P-value $= 0.00000738$
 (c) $(-0.871, -0.504)$
 (d) $z_0 = -0.394$, do not reject
  H_0, P-value $= 0.6936$

11-59. (a) $t_0 = 5.47$, reject H_0,
  P-value $\cong 0$
 (b) $(0.3358, 0.8007)$ (c) Yes
11-61. (a) $r = 0.933203$
 (b) $t_0 = 10.06$, reject H_0
 (c) $\hat{\beta}_0 = 0.72538$,
  $\hat{\beta}_1 = 0.498081$,
  $f_0 = 101.16$, reject H_0
 (d) $t_0 = 0.468345$, do not
  reject H_0

Supplemental

11-65. (a) $\hat{\beta}_0 = 93.34$, $\hat{\beta}_1 = 15.64$
 (b) $f_0 = 12.872$, reject H_0
 (c) $(7.961, 23.322)$
 (d) $(74.758, 111.923)$
 (e) $(126.18, 138.70)$
11-67. (b) $\hat{\beta}_0 = -0.8819$,
  $\hat{\beta}_1 = 0.00385$
 (c) $f_0 = 122.03$, reject H_0
 (d) No.   (e) $\hat{\beta}_0^* = 0.5967$,
  $\hat{\beta}_1^* = 0.00097$
11-69. $\hat{y} = 0.7916x$
11-71. (b) $\hat{\beta}_0 = -193$, $\hat{\beta}_1 = 15.296$
 (c) $(-4.912, 35.504)$
11-75. (b) $\hat{\beta}_0 = 66$, $\hat{\beta}_1 = 0.930$
 (c) $f_0 = 19.79$, reject H_0
  $R^2 = 71.2\%$
 (d) $t_0 = -0.1953$, cannot
  reject H_0

CHAPTER 12

Section 12-1

12-1. (b) $\hat{\boldsymbol{\beta}} = \begin{bmatrix} 171.054 \\ 3.713 \\ -1.126 \end{bmatrix}$
 (c) 189.481
12-3. (b) 2
12-5. (a) $\hat{y} = 33.4491 - 0.05435x_1 +$
  $1.07822x_2$
 (b) 8.03   (c) 19.30
12-7. (a) $\hat{y} = 383.80 - 3.6381x_1 -$
  $0.1119x_2$
 (b) $\hat{\sigma}^2 = 153.0$, $se(\hat{\beta}_0) = 36.22$,
  $se(\hat{\beta}_1) = 0.5665$,
  $se(\hat{\beta}_2) = 0.04338$
 (c) 180.95
 (d) $\hat{y} = 484.0 - 7.656$
  $x_1 - 0.222$
  $x_2 - 0.0041x_{12}$
 (e) $\hat{\sigma}^2 = 147.0$, $se(\hat{\beta}_0) = 101.3$,
  $se(\hat{\beta}_1) = 3.846$,
  $se(\hat{\beta}_2) = 0.113$,
  $se(\hat{\beta}_{12}) = 0.0039$
 (f) -31.3

12-9. (a) $\hat{y} = 47.174 - 9.7352x_1 + 0.4283x_2 + 18.2375x_3$
(b) 12 (c) $se(\hat{\beta}_0) = 49.5815$, $se(\hat{\beta}_1) = 3.6916$, $se(\hat{\beta}_2) = 0.2239$, $se(\hat{\beta}_3) = 1.312$ (d) 91.43

12-11. $\hat{y} = -8.0119 + 0.494x_1 + 0.0018x_2 + 0.0023x_3 + 0.0383x_4 - 0.2068x_5 - 0.0128x_6 + 0.030x_7 + 0.0407x_8 - 0.2083x_9$
$\hat{\sigma}^2 = 2.32$, $se(\hat{\beta}_0) = 16.18$, $se(\hat{\beta}_1) = 0.0481$, $se(\hat{\beta}_2) = 0.0064$, $se(\hat{\beta}_3) = 0.0209$, $se(\hat{\beta}_4) = 0.0515$, $se(\hat{\beta}_5) = 0.2611$, $se(\hat{\beta}_6) = 0.0266$, $se(\hat{\beta}_7) = 0.038$, $se(\hat{\beta}_8) = 0.1483$, $se(\hat{\beta}_9) = 0.1110$

Section 12-2

12-13. (a) 260.09, reject H_0
(b) reject H_0 both significant

12-15. (a) $f_0 = 25.7465$, reject H_0 P-value < 0.000001
(b) Reject H_0, all coefficients are significant

12-17. (a) $f_0 = 53.3162$, reject H_0
(b) Only β_1 is significant

12-19. (a) $f_0 = 10.08$, P-value $= 0.005$
(b) Only β_1 is significant

12-21. (a) $f_0 = 67.92$, reject H_0
(b) $f_0 = 1.07$, do not reject H_0
(c) 147.0

12-23. (a) $f_0 = 850.55$, reject H_0
(b) Regression coefficients for x_1 and x_3 are significant

12-25. (a) $f_0 = 101.79$, reject H_0
(b) Only regression coefficient for "PTS" is significant
(c) $\hat{y} = -5.531 + 0.497x_{PTS} - 0.004x_{PPG}, f_0 = 510.12$
reject H_0 only regressor "PTS" is significant

Section 12-3 and Section 12-4

12-27. (a) $(-0.00657, -0.00122)$
(b) 0.497648   (c) (7.16, 9.22)

12-29. (a) $0.0972 \le \beta_1 \le 1.4174$, $-1.9646 \le \beta_2 \le 17.0026$, $-1.7953 \le \beta_3 \le 6.7613$, $-1.7941 \le \beta_4 \le 0.8319$

(b) (272.44, 308.44)
(c) (257.25, 323.64)

12-31. (a) $-0.595 \le \beta_2 \le 0.535$, $0.229 \le \beta_3 \le 0.812$, $-0.216 \le \beta_4 \le 0.013$, $-7.298 \le \beta_5 \le 2.977$
(b) (7.982, 10.009)
(c) (6.8481, 11.143)

12-33. (a) $-0.00003 \le \beta_{Temp} \le 0.00012$, $0.00203 \le \beta_{soaktime} \le 0.00288$, $-0.02306 \le \beta_{soakpct} \le 0.05976$, $0.00501 \le \beta_{DFtime} \le 0.01056$, $-0.01969 \le \beta_{Diffpct} \le 0.01342$
(b) (0.0206, 0.0234)

12-35. (a) (0.3882, 0.5998)
(b) $y = -5.767703 + 0.496501x_{Pts}$
(c) (0.4648, 0.5282)

Section 12-5

12-37. (a) 0.82897   (d) No
12-39. (a) 0.985   (b) 0.99
12-41. (b) 0.9937
12-43. (a) 0.9582   (c) 32
12-45. (a) 0.12
(b) 17 and 18

Section 12-6

12-47. (a) $\hat{y} = -1.633 + 1.232x - 1.495x^2$
(b) $f_0 = 1858613$, reject H_0
(c) $t_0 = -601.64$, reject H_0
12-49. (a) 802.943
(b) $\hat{y} = -26204.14 + 189.09x - 0.331x^2$
12-51. (a) $\hat{y} = -1.769 + 0.421x_1 + 0.222x_2 - 0.128x_3 - 0.02x_1x_2 + 0.009x_1x_3 + 0.003x_2x_3 - 0.019x_1^2 - 0.007x_2^2 + 0.001x_3^2$
(b) $f_0 = 19.628$, reject H_0
(d) $f_0 = 1.612$, do not reject H_0
12-55. (a) Min. MS_E: x_1, x_3, x_4, x_5, x_7, $x_8, x_{10}, MS_E = 6.58$, $C_p = 5.8$, Min. C_p: x_5, x_8, x_{10}, $C_p = 5.02, MS_E = 7.97$
(b) $\hat{y} = 34.434 - 0.048x_1$, $MS_E = 8.81, C_p = 5.55$
(c) Same as part (b)
(d) $\hat{y} = 0.341 + 2.862x_5 + 0.246x_8 - 0.010x_{10}$, $MS_E = 7.97, C_p = 5.02$

12-57. (a) $y = 4.656 + 0.511x_3 - 0.124x_4$
(b) Same as part (a)
(c) Same as part (a)
(d) All models are the same
12-59. (a) $\hat{y} = -0.304 + 0.083x_1 - 0.031x_3 + 0.004x_2^2$, $C_p = 4.04, MS_E = 0.004$
(b) $\hat{y} = -0.256 + 0.078x_1 + 0.022x_2 - 0.042x_3 + 0.0008x_3^2$, $C_p = 4.66, MS_E = 0.004$
12-61. (a) Min. C_p: $x_1, x_9, C_p = -1.67$
(b) Min. MS_E: x_1, x_7, x_9, $MS_E = 1.67, C_p = -0.77$
(c) Max. adjusted R^2: x_1, x_7, x_9, Adj. $R^2 = 0.98448$

Supplemental

12-65. (a) $f_0 = 1323.62$, reject H_0 P-value < 0.00001
(b) Only regressor x_4 is significant H_0
12-67. (a) $\hat{y} = -0.908 + 5.482x_1^* + 1.126x_2^* - 3.920x_3^* - 1.143x_4^*$
(b) $f_0 = 109.02$, reject H_0, all regressors are significant
12-69. (a) $\hat{y} = -3982.1 + 1.0964x_1 + 0.1843x_3 + 3.7456x_4 + 0.8343x_5 - 16.2781x_6$, $MS_E(p) = 694.93, C_p = 5.62$
(b) $\hat{y} = -4280.2 + 1.442x_1 + 0.209x_3 + 0.6467x_5 - 17.5103x_6, MS_E(p) = 714.20, C_p = 5.57$
(c) Same as model b
12-71. $VIF(\hat{\beta}_3^*) = 51.86$, $VIF(\hat{\beta}_4) = 9.11$, $VIF(\hat{\beta}_5) = 28.99$
12-73. (a) $f_0 = 18.28$, reject H_0
(b) $f_0 = 2$, do not reject H_0

CHAPTER 13

Section 13-2

13-1. (a) Reject H_0
(b) Model is satisfactory
13-3. (a) Reject H_0 (b) P-value $\cong 0$
13-5. (a) Reject H_0 (c) (140.71, 149.29), (7.36, 24.14)
13-7. (a) Do not reject H_0
(b) P-value $= 0.214$
13-9. (a) Reject H_0
(b) P-value $= 0.002$

(d) (69.17, 81.81)

(e) (8.42, 26.33)

13-19. 5

Section 13-3

13-21. (a) Reject H_0 (b) 0.01412

(c) 0.0148

13-23. (a) Do not reject H_0 (b) 0

(c) 24

Section 13-4

13-25. (a) Reject H_0

13-27. (a) Do not reject H_0

13-29. (a) Do not reject H_0

Supplemental

13-31. (a) Reject H_0

(c) (132.97, 147.83)

13-35. (a) Reject H_0

(b) P-value $= 0.007$

13-37. (a) Reject H_0

13-39. (a) 0.85   (b) 5

CHAPTER 14

Section 14-4

14-1. (a) Reject H_0 for both main effects and the interaction

14-3. (a) Reject H_0 for main effects

14-7. $(-3.40, 7.64)$

14-9. (a) Reject H_0 for both main effects and the interaction

Section 14-5

14-11. (a) All these main effects are significant and the hardwood concentration-freeness interaction is significant at $\alpha - 0.05$. The P-value for the hardwood-cooking time interaction is 0.075, it is possibly an important effect as well.

Section 14-7

14-13. (a) Reject H_0 for factors B, C, and AC

(b) $\hat{y} = 413.125 + 9.125x_1 + 45.12x_2 + 35.87x_3 - 59.62x_1x_3$

14-15. $\hat{y} = 175.25 - 4.12x_1 + 5.19x_2 + 0.19x_4 + 4.62x_1x_4$

14-17. (b) Reject H_0 for factor B

14-19. (a) Factors A, B, C, and AB

14-21. (b) Factors A, B, and AB

(c) $\hat{y} = 400 + 40.124x_1 - 32.75x_2 + 26.625x_1x_2$

Section 14-8

14-23. Block 1: (1) ab ac bc

Block 2: a b c abc

There are no significant factors

14-25. Block 1: (1) ac bd $abcd$

Block 2: a c abd bcd

Block 3: b abc d acd

Block 4: ab bc ad cd

Factor A is significant

14-27. Block 1: (1) ab de acd bcd ace bce $abde$

Block 2: a b cd ce ade bde $abce$ $abcd$

Block 3: d e bc bd abd abe $acde$ $bcde$

Block 4: c ad ae bd be abc cde $abcde$

14-29. (a) Factors A, C, AB, and AC are significant

Section 14-9

14-31. (a) Factors A, B, and D are significant

(c) Factors A, B, D, AB, and AD are significant

14-33. (b) Design Generators: $D = AB$, $E = AC$; Defining Relation: $I = ABD = ACE = BCDE$; Aliases: $A = BD = CD = ABCDE$, $B = AD = CDE = ABCE$; $C = AE = BDE = ABCD$, $D = AB = BCE = ACDE$, $E = AC = BCD = ABDE$ (c) $A = -1.525$, $B = -5.175$, $C = 2.275$, $D = -0.675$, $E = 2.275$

14-35. 2^{4-1} replicated twice

14-37. Factors A, B, and D are significant

14-39. Design Generators: $D = AB$, $E = AC$, $F = BC$; Defining Relations: $I = ABD = ACE = BCF = BCDE = ACDF = ABEF = DEF$; Aliases: $A = BD = CE$, $B = AD = CF$, $C = AE = BF$, $D = AB = EF$, $E = AC = DF$, $F = BC = DE$, $AB = EF$, $AF = BE = CD$

Supplemental

14-41. The main effect of pH and the interaction of pH and

Catalyst Concentration are significant

14-43. The salts, application levels, and the interaction between salts and application levels are significant

14-45. There are no significant factors

14-47. (a) The factors V, P, G, and PG are significant. Effects $P = -10.75$, $V = 15.75$, $G = -25.00$, $PG = 19.25$

(b) $\hat{y} = 102.75 + 7.88x_1 - 5.37x_2 - 12.50x_4 + 9.62x_2x_4$

14-49. The factors V and G are significant at $\alpha = 0.10$. $\hat{y} = 100.63 - 14.12x_1 - 13.13x_4$

14-51. Design Generators: $D = \pm AB$, $E = \pm AC$; Defining Relations: $I = ABD = ACE = BCDE$; Aliases: $A = BD = CE$, $B = AD = CDE$, $C = AE = BDE$, $D = AB = BCE$, $E = AC = BCD$, $BC = DE$, $BE = CD$

14-53. (a) $E = ABCD$ (b) Factors A, B, C, E, and interaction BE are significant (c) Factor A is significant in affecting variability

CHAPTER 15

Section 15-2

15-1. Do not reject H_0, P-value $= 0.109$

15-3. Reject H_0, P-value $= 0.0002$

15-5. (a) Do not reject H_0

(b) $z_0 = 0.577$, P-value $= 0.281$

15-7. $z_0 = -1.34$, do not reject H_0, P-value $= 0.1802$

15-9. Do not reject H_0

15-11. $z_0 = 2.24$, reject H_0

15-13. Reject H_0

15-15. $z_0 = 2.84$, reject H_0

15-17. (a) 0.025   (b) 0.115

(c) 0.011   (d) 0.1587

15-19. P-value $= 0.04$

Section 15-3

15-21. $w = 71 > 52$, do not reject H_0

15-23. $w = 8 < 65$, reject H_0

15-25. $w = 25 < 52$, reject H_0

15-27. $w = 1 < 25$, reject H_0

Section 15-4

15-29. $w = 38 > 23$, do not reject H_0

15-31. $z_0 = -2.78$, do not reject H_0, P-value $= 0.9973$

15-33. $w = 55 < 78$, reject H_0

15-35. $z_0 = -3.77$, reject H_0, P-value $= 0.0001$

Section 15-5

15-37. Reject H_0

15-39. Do not reject H_0

15-41. P-value $= 0.018$

Supplemental

15-43. Do not reject H_0, P-value $\cong 1$

15-45. Do not reject H_0

15-47. Do not reject H_0

15-49. Reject H_0

15-51. Reject H_0

15-53. Reject H_0

15-55. Reject H_0, P-value $\cong 0$

15-57. Reject H_0, P-value $= 0.009$

CHAPTER 16

Section 16-5

16-1. (a) $\bar{x}$ chart: $UCL = 37.5789$, $CL = 34.32$, $LCL = 31.0611$ R chart: $UCL = 11.9461$, $CL = 5.65$, $LCL = 0$

(b) 1 point outside limits on $\bar{x}$ chart. Revised limits: $\bar{x}$ chart: $UCL = 37.4038$, $CL = 34.0947$, $LCL = 30.7857$, R chart: $UCL = 12.1297$, $CL = 5.7368$, $LCL = 0$

16-3. (a) $\bar{x}$ chart: $UCL = 17.40$, $CL = 15.09$, $LCL = 12.79$ R chart: $UCL = 5.792$, $CL = 2.25$, $LCL = 0$

(b) $\bar{x}$ chart: $UCL = 17.96$, $CL = 15.78$, $LCL = 16.62$ R chart: $UCL = 5.453$, $CL = 2.118$, $LCL = 0$

(c) $\bar{x}$ chart: $UCL = 17.42$, $CL = 15.09$, $LCL = 12.77$ s chart: $UCL = 3.051$, $CL = 1.1188$, $LCL = 0$ revised limits: $\bar{x}$ chart: $UCL = 17.95$, $CL = 15.78$, $LCL = 13.62$, s chart: $UCL = 2.848$, $CL = 1.109$, $LCL = 0$

16-5. (a) $\bar{x}$ chart: $UCL = 242.78$, $CL = 223$, $LCL = 203.22$ R chart: $UCL = 72.51$, $CL = 34.286$, $LCL = 0$

(b) $\hat{\mu} = 223$, $\hat{\sigma} = 14.74$

16-7. (a) $\bar{x}$ chart: $UCL = 0.06347$, $CL = 0.06294$, $LCL = 0.0624$ R chart: $UCL = 0.001954$, $CL = 0.000924$, $LCL = 0$

(b) $\bar{x}$ chart: $UCL = 0.06346$, $CL = 0.06295$, $LCL = 0.06241$ s chart: $UCL = 0.000766$, $CL = 0.000367$, $LCL = 0$

(c) The points are 1, 5, 14, 17, 20, 21, and 22; or outside the control limits of the R chart: 6 and 15

Section 16-6

16-9. (a) I chart: $UCL = 60.8887$, $CL = 53.05$, $LCL = 45.2113$ MR chart: $UCL = 9.63382$, $CL = 2.94737$, $LCL = 0$

(b) $\hat{\mu} = 53.05$, $\hat{\sigma} = 2.613$

16-11. (a) I chart: $UCL = 10.5358$, $CL = 10.0272$, $LCL = 9.51856$ MR chart: $UCL = 0.625123$, $CL = 0.19125$, $LCL = 0$

(b) $\hat{\mu} = 10.027$, $\hat{\sigma} = 0.1696$

Section 16-7

16-13. (a) $PCR = PCR_k = 1.5$

(b) 0

16-15. (a) 0.00075 (b) $PCR = 1.13$, $PCR_k = 1.104$

16-17. (a) $PCR = PCR_k = 1.18$

(b) 0.00046

16-19. (a) 0.0009 (b) $PCR = 1.13$, $PCR_k = 1.06$

16-21. $PCR = 0.50$, $PCR_k = 0.357$

16-23. $PCR = 0.49$, $PCR_k = 0.474$

Section 16-8

16-25. (a) U chart: $UCL = 3.811$, $CL = 1.942$, $LCL = 0.0722$

(b) Revised limits: U chart: $UCL = 3.463$, $CL = 1.709$, $LCL = 0$

16-27. (c) chart: $UCL = 19.06$, $CL = 9.708$, $LCL = 0.3609$

Section 16-9

16-29. (a) 0.2177 (b) 4.6

16-31. (a) 0.1020 (b) 9.8

16-33. (a) 0.0548 (b) 18.25

16-35. (a) 0.1515 (b) 6.6

16-37. (a) 0.16603 (b) 6.02

Section 16-10

16-39. (a) $\hat{\sigma} = 0.1695$

16-41. (a) ARL $= 38.0$

(b) ARL $= 10.4$

Supplemental

16-43. (a) $\bar{x}$ chart: $UCL = 64.0181$, $CL = 64.0$, $LCL = 63.982$ R chart: $UCL = 0.0453972$, $CL = 0.01764$, $LCL = 0$

(b) $\hat{\mu} = 64$, $\hat{\sigma} = 0.0104$

(c) $PCR = 0.641$,

(d) $PCR_k = 0.641$

(e) $\sigma^2 = 0.025$,

(f) 0.1705, ARL $= 5.87$

16-45. (a) p chart: $UCL = 0.20387$, $CL = 0.11$, $LCL = 0.01613$

(b) p chart: $UCL = 0.1717$, $CL = 0.106$, $LCL = 0.04092$

16-47. (a) c chart: $UCL = 7.51442$, $CL = 2.64$, $LCL = 0$

(b) c chart: $UCL = 6.50924$, $CL = 2.1304$, $LCL = 0$

16-49. (b) 6.30 (c) 2

16-51. (a) $\bar{x}$ chart: $UCL = 140.168$, $CL = 139.49$, $LCL = 138.812$ R chart: $UCL = 2.48437$, $CL = 1.175$, $LCL = 0$

(b) Revised control limits: $\bar{x}$ chart: $UCL = 140.518$, $CL = 139.808$, $LCL = 139.098$ R chart: $UCL = 2.6023$, $CL = 1.231$, $LCL = 0$

(c) $PCR = 1.26$, $PCR_k = 1.14$

(d) $\sigma^2 = 0.091$

(e) 0.1877, ARL $= 5.33$

16-53. (a) 0.96995 (b) 1

16-57. 0.000135