Chapter 1

1.1	$(2/3)^{10} = 0.0173$ yd; $6(2/3)^{10} = 0.104$ yd (compared to a total of 5 yd)				
1.3	5/9	1.4	9/11	1.5	7/12
1.6	11/18	1.7	5/27	1.8	25/36
1.9	6/7	1.10	15/26	1.11	19/28
1.13	\$1646.99	1.15	Blank area = 1		
1.16	At $x = 1$: $1/(1+r)$; at $x = 0$: $r/(1+r)$; maximum escape at $x = 0$ is 1/2.				

2.1	1	2.2	1/2	2.3	0
2.4	∞	2.5	0	2.6	∞
2.7	e^2	2.8	0	2.9	1

4.1 $a_n = 1/2^n \to 0$; $S_n = 1 - 1/2^n \to 1$; $R_n = 1/2^n \to 0$

4.2 $a_n = 1/5^{n-1} \to 0$; $S_n = (5/4)(1 - 1/5^n) \to 5/4$; $R_n = 1/(4 \cdot 5^{n-1}) \to 0$

4.3 $a_n = (-1/2)^{n-1} \to 0$; $S_n = (2/3)[1 - (-1/2)^n] \to 2/3$; $R_n = (2/3)(-1/2)^n \to 0$

4.4 $a_n = 1/3^n \to 0$; $S_n = (1/2)(1 - 1/3^n) \to 1/2$; $R_n = 1/(2 \cdot 3^n) \to 0$

4.5 $a_n = (3/4)^{n-1} \to 0$; $S_n = 4[1 - (3/4)^n] \to 4$; $R_n = 4(3/4)^n \to 0$

4.6 $a_n = \dfrac{1}{n(n+1)} \to 0$; $S_n = 1 - \dfrac{1}{n+1} \to 1$; $R_n = \dfrac{1}{n+1} \to 0$

4.7 $a_n = (-1)^{n+1}\left(\dfrac{1}{n} + \dfrac{1}{n+1}\right) \to 0$; $S_n = 1 + \dfrac{(-1)^{n+1}}{n+1} \to 1$; $R_n = \dfrac{(-1)^n}{n+1} \to 0$

5.1	D	5.2	Test further	5.3	Test further
5.4	D	5.5	D	5.6	Test further
5.7	Test further	5.8	Test further		
5.9	D	5.10	D		

6.5 (a) D   6.5 (b) D

Note: In the following answers, $I = \int^{\infty} a_n\,dn$; ρ = test ratio.

6.7	D, $I = \infty$	6.8	D, $I = \infty$	6.9	C, $I = 0$
6.10	C, $I = \pi/6$	6.11	C, $I = 0$	6.12	C, $I = 0$
6.13	D, $I = \infty$	6.14	D, $I = \infty$	6.18	D, $\rho = 2$
6.19	C, $\rho = 3/4$	6.20	C, $\rho = 0$	6.21	D, $\rho = 5/4$
6.22	C, $\rho = 0$	6.23	D, $\rho = \infty$	6.24	D, $\rho = 9/8$
6.25	C, $\rho = 0$	6.26	C, $\rho = (e/3)^3$	6.27	D, $\rho = 100$
6.28	C, $\rho = 4/27$	6.29	D, $\rho = 2$	6.31	D, cf. $\sum n^{-1}$
6.32	D, cf. $\sum n^{-1}$	6.33	C, cf. $\sum 2^{-n}$	6.34	C, cf. $\sum n^{-2}$
6.35	C, cf. $\sum n^{-2}$	6.36	D, cf. $\sum n^{-1/2}$		

7.1	C	7.2	D	7.3	C	7.4	C
7.5	C	7.6	D	7.7	C	7.8	C

9.1 D, cf. $\sum n^{-1}$
9.2 D, $a_n \not\to 0$
9.3 C, I $= 0$
9.4 D, I $= \infty$, or cf. $\sum n^{-1}$
9.5 C, cf. $\sum n^{-2}$
9.6 C, $\rho = 1/4$
9.7 D, $\rho = 4/3$
9.8 C, $\rho = 1/5$
9.9 D, $\rho = e$
9.10 D, $a_n \not\to 0$
9.11 D, I $= \infty$, or cf. $\sum n^{-1}$
9.12 C, cf. $\sum n^{-2}$
9.13 C, I $= 0$, or cf. $\sum n^{-2}$
9.14 C, alt. ser.
9.15 D, $\rho = \infty$, $a_n \not\to 0$
9.16 C, cf. $\sum n^{-2}$
9.17 C, $\rho = 1/27$
9.18 C, alt. ser.
9.19 C
9.20 C
9.21 C, $\rho = 1/2$
9.22 (a) C (b) D (c) $k > e$

10.1 $|x| < 1$
10.2 $|x| < 3/2$
10.3 $|x| \le 1$
10.4 $|x| \le \sqrt{2}$
10.5 All x
10.6 All x
10.7 $-1 \le x < 1$
10.8 $-1 < x \le 1$
10.9 $|x| < 1$
10.10 $|x| \le 1$
10.11 $-5 \le x < 5$
10.12 $|x| < 1/2$
10.13 $-1 < x \le 1$
10.14 $|x| < 3$
10.15 $-1 < x < 5$
10.16 $-1 < x < 3$
10.17 $-2 < x \le 0$
10.18 $-3/4 \le x \le -1/4$
10.19 $|x| < 3$
10.20 All x
10.21 $0 \le x \le 1$
10.22 No x
10.23 $x > 2$ or $x < -4$
10.24 $|x| < \sqrt{5}/2$
10.25 $n\pi - \pi/6 < x < n\pi + \pi/6$

13.4 $\binom{-1/2}{0} = 1$; $\binom{-1/2}{n} = \dfrac{(-1)^n(2n-1)!!}{(2n)!!}$

Answers to part (b), Problems 5 to 19:

13.5 $-\sum_1^\infty \dfrac{x^{n+2}}{n}$

13.6 $\sum_0^\infty \binom{1/2}{n} x^{n+1}$ (see Example 2)

13.7 $\sum_0^\infty \dfrac{(-1)^n x^{2n}}{(2n+1)!}$

13.8 $\sum_0^\infty \binom{-1/2}{n} (-x^2)^n$ (see Problem 13.4)

13.9 $1 + 2\sum_1^\infty x^n$

13.10 $\sum_0^\infty \dfrac{(-1)^n x^{4n+2}}{(2n+1)!}$

13.11 $\sum_0^\infty \dfrac{(-1)^n x^n}{(2n+1)!}$

13.12 $\sum_0^\infty \dfrac{(-1)^n x^{4n+1}}{(2n)!(4n+1)}$

13.13 $\sum_0^\infty \dfrac{(-1)^n x^{2n+1}}{n!(2n+1)}$

13.14 $\sum_0^\infty \dfrac{x^{2n+1}}{2n+1}$

13.15 $\sum_0^\infty \binom{-1/2}{n} (-1)^n \dfrac{x^{2n+1}}{2n+1}$

13.16 $\sum_0^\infty \dfrac{x^{2n}}{(2n)!}$

13.17 $2\sum_{\mathrm{odd}\, n}^\infty \dfrac{x^n}{n}$

13.18 $\sum_0^\infty \dfrac{(-1)^n x^{2n+1}}{(2n+1)(2n+1)!}$

13.19 $\sum_0^\infty \binom{-1/2}{n} \dfrac{x^{2n+1}}{2n+1}$

13.20 $x + x^2 + x^3/3 - x^5/30 - x^6/90 \cdots$
13.21 $x^2 + 2x^4/3 + 17x^6/45 \cdots$
13.22 $1 + 2x + 5x^2/2 + 8x^3/3 + 65x^4/24 \cdots$
13.23 $1 - x + x^3 - x^4 + x^6 \cdots$

13.24 $1 + x^2/2! + 5x^4/4! + 61x^6/6! \cdots$
13.25 $1 - x + x^2/3 - x^4/45 \cdots$
13.26 $1 + x^2/4 + 7x^4/96 + 139x^6/5760 \cdots$
13.27 $1 + x + x^2/2 - x^4/8 - x^5/15 \cdots$
13.28 $x - x^2/2 + x^3/6 - x^5/12 \cdots$
13.29 $1 + x/2 - 3x^2/8 + 17x^3/48 \cdots$
13.30 $1 - x + x^2/2 - x^3/2 + 3x^4/8 - 3x^5/8 \cdots$
13.31 $1 - x^2/2 - x^3/2 - x^4/4 - x^5/24 \cdots$
13.32 $x + x^2/2 - x^3/6 - x^4/12 \cdots$
13.33 $1 + x^3/6 + x^4/6 + 19x^5/120 + 19x^6/120 \cdots$
13.34 $x - x^2 + x^3 - 13x^4/12 + 5x^5/4 \cdots$
13.35 $1 + x^2/3! + 7x^4/(3 \cdot 5!) + 31x^6/(3 \cdot 7!) \cdots$
13.36 $u^2/2 + u^4/12 + u^6/20 \cdots$
13.37 $-(x^2/2 + x^4/12 + x^6/45 \cdots)$
13.38 $e(1 - x^2/2 + x^4/6 \cdots)$
13.39 $1 - (x - \pi/2)^2/2! + (x - \pi/2)^4/4! \cdots$
13.40 $1 - (x - 1) + (x - 1)^2 - (x - 1)^3 \cdots$
13.41 $e^3[1 + (x - 3) + (x - 3)^2/2! + (x - 3)^3/3! \cdots]$
13.42 $-1 + (x - \pi)^2/2! - (x - \pi)^4/4! \cdots$
13.43 $-[(x - \pi/2) + (x - \pi/2)^3/3 + 2(x - \pi/2)^5/15 \cdots]$
13.44 $5 + (x - 25)/10 - (x - 25)^2/10^3 + (x - 25)^3/(5 \cdot 10^4) \cdots$

14.6 Error $< (1/2)(0.1)^2 \div (1 - 0.1) < 0.0056$
14.7 Error $< (3/8)(1/4)^2 \div (1 - \frac{1}{4}) = 1/32$
14.8 For $x < 0$, error $< (1/64)(1/2)^4 < 0.001$
For $x > 0$, error $< 0.001 \div (1 - \frac{1}{2}) = 0.002$
14.9 Term $n + 1$ is $a_{n+1} = \frac{1}{(n+1)(n+2)}$, so $R_n = (n + 2)a_{n+1}$.
14.10 $S_4 = 0.3052$, error < 0.0021 (cf. $S = 1 - \ln 2 = 0.307$)

15.1 $-x^4/24 - x^5/30 \cdots \simeq -3.376 \times 10^{-16}$
15.2 $x^8/3 - 14x^{12}/45 \cdots \simeq 1.433 \times 10^{-16}$
15.3 $x^5/15 - 2x^7/45 \cdots \simeq 6.667 \times 10^{-17}$
15.4 $x^3/3 + 5x^4/6 \cdots \simeq 1.430 \times 10^{-11}$
15.5 0　15.6 12　15.7 10!
15.8 1/2　15.9 $-1/6$　15.10 -1
15.11 4　15.12 1/3　15.13 -1
15.14 $t - t^3/3$, error $< 10^{-6}$　15.15 $\frac{2}{3}t^{3/2} - \frac{2}{5}t^{5/2}$, error $< \frac{1}{7}10^{-7}$
15.16 $e^2 - 1$　15.17 $\cos \frac{\pi}{2} = 0$
15.18 $\ln 2$　15.19 $\sqrt{2}$
15.20 (a) 1/8　(b) $5e$　(c) 9/4
15.21 (a) 0.397117　(b) 0.937548　(c) 1.291286
15.22 (a) $\pi^4/90$　(b) 1.202057　(c) 2.612375
15.23 (a) 1/2　(b) 1/6　(c) 1/3　(d) $-1/2$
15.24 (a) $-\pi$　(b) 0　(c) -1
(d) 0　(e) 0　(f) 0
15.27 (a) $1 - \frac{v}{c} = 1.3 \times 10^{-5}$, or $v = 0.999987c$
(b) $1 - \frac{v}{c} = 5.2 \times 10^{-7}$
(c) $1 - \frac{v}{c} = 2.1 \times 10^{-10}$
(d) $1 - \frac{v}{c} = 1.3 \times 10^{-11}$
15.28 $mc^2 + \frac{1}{2}mv^2$
15.29 (a) $F/W = \theta + \theta^3/3 \cdots$
(b) $F/W = x/l + x^3/(2l^3) + 3x^5/(8l^5) \cdots$

15.30 (a) $T = F(5/x + x/40 - x^3/16000\cdots)$
(b) $T = \frac{1}{2}(F/\theta)(1 + \theta^2/6 + 7\theta^4/360\cdots)$
15.31 (a) finite (b) infinite

16.1 (c)

overhang:	2	3	10	100
books needed:	32	228	2.7×10^8	4×10^{86}

16.4 C, $\rho = 0$
16.5 D, $a_n \not\to 0$
16.6 C, cf. $\sum n^{-3/2}$
16.7 D, $I = \infty$
16.8 D, cf. $\sum n^{-1}$
16.9 $-1 \le x < 1$
16.10 $|x| < 4$
16.11 $|x| \le 1$
16.12 $|x| < 5$
16.13 $-5 < x \le 1$
16.14 $1 - x^2/2 + x^3/2 - 5x^4/12\cdots$
16.15 $-x^2/6 - x^4/180 - x^6/2835\cdots$
16.16 $1 - x/2 + 3x^2/8 - 11x^3/48 + 19x^4/128\cdots$
16.17 $1 + x^2/2 + x^4/4 + 7x^6/48\cdots$
16.18 $x - x^3/3 + x^5/5 - x^7/7\cdots$
16.19 $-(x-\pi) + (x-\pi)^3/3! - (x-\pi)^5/5!\cdots$
16.20 $2 + (x-8)/12 - (x-8)^2/(2^5 \cdot 3^2) + 5(x-8)^3/(2^8 \cdot 3^4)\cdots$
16.21 $e[1 + (x-1) + (x-1)^2/2! + (x-1)^3/3!\cdots]$
16.22 arc tan $1 = \pi/4$
16.23 $1 - (\sin\pi)/\pi = 1$
16.24 $e^{\ln 3} - 1 = 2$
16.25 -2
16.26 $-1/3$
16.27 $2/3$
16.28 1
16.29 6!
16.30 (b) For $N = 130$, $10.5821 < \zeta(1.1) < 10.5868$
16.31 (a) 10^{430} terms. For $N = 200$, $100.5755 < \zeta(1.01) < 100.5803$
16.31 (b) 2.66×10^{86} terms. For $N = 15$, $1.6905 < S < 1.6952$
16.31 (c) $e^{e^{200}} = 10^{3.1382\times 10^{86}}$ terms. For $N = 40$, $38.4048 < S < 38.4088$

Chapter 2

	x	y	r	θ
4.1	1	1	$\sqrt{2}$	$\pi/4$
4.2	-1	1	$\sqrt{2}$	$3\pi/4$
4.3	1	$-\sqrt{3}$	2	$-\pi/3$
4.4	$-\sqrt{3}$	1	2	$5\pi/6$
4.5	0	2	2	$\pi/2$
4.6	0	-4	4	$-\pi/2$
4.7	-1	0	1	π
4.8	3	0	3	0
4.9	-2	2	$2\sqrt{2}$	$3\pi/4$
4.10	2	-2	$2\sqrt{2}$	$-\pi/4$
4.11	$\sqrt{3}$	1	2	$\pi/6$
4.12	-2	$-2\sqrt{3}$	4	$-2\pi/3$
4.13	0	-1	1	$3\pi/2$
4.14	$\sqrt{2}$	$\sqrt{2}$	2	$\pi/4$
4.15	-1	0	1	$-\pi$ or π
4.16	5	0	5	0
4.17	1	-1	$\sqrt{2}$	$-\pi/4$
4.18	0	3	3	$\pi/2$
4.19	4.69	1.71	5	$20^\circ = 0.35$
4.20	-2.39	-6.58	7	$-110^\circ = -1.92$
5.1	$1/2$	$-1/2$	$1/\sqrt{2}$	$-\pi/4$
5.2	$-1/2$	$-1/2$	$1/\sqrt{2}$	$-3\pi/4$ or $5\pi/4$
5.3	1	0	1	0
5.4	0	2	2	$\pi/2$
5.5	2	$2\sqrt{3}$	4	$\pi/3$
5.6	-1	0	1	π
5.7	$7/5$	$-1/5$	$\sqrt{2}$	$-8.13^\circ = -0.14$
5.8	1.6	-2.7	3.14	$-59.3^\circ = -1.04$
5.9	-10.4	22.7	25	$2 = 114.6^\circ$
5.10	$-25/17$	$19/17$	$\sqrt{58/17}$	$142.8^\circ = 2.49$
5.11	17	-12	20.8	$-35.2^\circ = -0.615$
5.12	2.65	1.41	3	$28^\circ = 0.49$
5.13	1.55	4.76	5	$2\pi/5$
5.14	1.27	-2.5	2.8	$-1.1 = -63^\circ$
5.15	$21/29$	$-20/29$	1	$-43.6^\circ = -0.76$
5.16	1.53	-1.29	2	$-40^\circ = -0.698$
5.17	-7.35	-10.9	13.1	$-124^\circ = -2.16$
5.18	-0.94	-0.36	1	201° or -159°, 3.51 or -2.77

5.19 $(2+3i)/13$; $(x-yi)/(x^2+y^2)$
5.20 $(-5+12i)/169$; $(x^2-y^2-2ixy)/(x^2+y^2)^2$
5.21 $(1+i)/6$; $(x+1-iy)/[(x+1)^2+y^2]$
5.22 $(1+2i)/10$; $[x-i(y-1)]/[x^2+(y-1)^2]$
5.23 $(-6-3i)/5$; $(1-x^2-y^2+2yi)/[(1-x)^2+y^2]$
5.24 $(-5-12i)/13$; $(x^2-y^2+2ixy)/(x^2+y^2)$

5.26	1	5.27	$\sqrt{13/2}$	5.28	1
5.29	$5\sqrt{5}$	5.30	$3/2$	5.31	1
5.32	169	5.33	5	5.34	1

5.35	$x=-4$, $y=3$	5.36	$x=-1/2$, $y=3$
5.37	$x=y=0$	5.38	$x=-7$, $y=2$
5.39	$x=y=$ any real number	5.40	$x=0$, $y=3$
5.41	$x=1$, $y=-1$	5.42	$x=-1/7$, $y=-10/7$

5.43 $(x,y)=(0,0)$, or $(1,1)$, or $(-1,1)$
5.44 $x=0$, $y=-2$
5.45 $x=0$, any real y; or $y=0$, any real x
5.46 $y=-x$
5.47 $(x,y)=(-1,0)$, $(1/2,\pm\sqrt{3}/2)$
5.48 $x=36/13$, $y=2/13$
5.49 $x=1/2$, $y=0$
5.50 $x=0$, $y\geq 0$
5.51 Circle, center at origin, radius $=2$
5.52 y axis
5.53 Circle, center at $(1,0)$, $r=1$
5.54 Disk, center at $(1,0)$, $r=1$
5.55 Line $y=5/2$
5.56 Positive y axis
5.57 Hyperbola, $x^2-y^2=4$
5.58 Half plane, $x>2$
5.59 Circle, center at $(0,-3)$, $r=4$
5.60 Circle, center at $(1,-1)$, $r=2$
5.61 Half plane, $y<0$
5.62 Ellipse, foci at $(1,0)$ and $(-1,0)$, semi-major axis $=4$
5.63 The coordinate axes
5.64 Straight lines, $y=\pm x$
5.67 $v=(4t^2+1)^{-1}$, $a=4(4t^2+1)^{-3/2}$
5.68 Motion around circle $r=1$, with $v=2$, $a=4$

6.2	D, $\rho=\sqrt{2}$	6.3	C, $\rho=1/\sqrt{2}$	6.4	D, $\lvert a_n\rvert=1\not\to 0$
6.5	D	6.6	C	6.7	D, $\rho=\sqrt{2}$
6.8	D, $\lvert a_n\rvert=1\not\to 0$	6.9	C	6.10	C, $\rho=\sqrt{2}/2$
6.11	C, $\rho=1/5$	6.12	C	6.13	C, $\rho=\sqrt{2/5}$

7.1	All z	7.2	$\lvert z\rvert<1$	7.3	All z
7.4	$\lvert z\rvert<1$	7.5	$\lvert z\rvert<2$	7.6	$\lvert z\rvert<1/3$
7.7	All z	7.8	All z	7.9	$\lvert z\rvert<1$
7.10	$\lvert z\rvert<1$	7.11	$\lvert z\rvert<27$	7.12	$\lvert z\rvert<4$
7.13	$\lvert z-i\rvert<1$	7.14	$\lvert z-2i\rvert<1$	7.15	$\lvert z-(2-i)\rvert<2$
7.16	$\lvert z+(i-3)\rvert<1/\sqrt{2}$				

8.3 See Problem 17.30.

9.1	$(1-i)/\sqrt{2}$	9.2	i	9.3	$-9i$
9.4	$-e(1+i\sqrt{3})/2$	9.5	-1	9.6	1
9.7	$3e^2$	9.8	$-\sqrt{3}+i$	9.9	$-2i$
9.10	-2	9.11	$-1\ -i$	9.12	$-2-2i\sqrt{3}$
9.13	$-4+4i$	9.14	64	9.15	$2i-4$
9.16	$-2\sqrt{3}-2i$	9.17	$-(1+i)/4$	9.18	1
9.19	16	9.20	i	9.21	1
9.22	$-i$	9.23	$(\sqrt{3}+i)/4$	9.24	$4i$
9.25	-1	9.26	$(1+i\sqrt{3})/2$	9.29	1
9.30	$e^{\sqrt{3}}$	9.31	5	9.32	$3e^2$
9.33	$2e^3$	9.34	$4/e$	9.35	21
9.36	4	9.37	1	9.38	$1/\sqrt{2}$

10.1 $1,\ (-1\pm i\sqrt{3})/2$ 10.2 $3,\ 3(-1\pm i\sqrt{3})/2$
10.3 $\pm1,\ \pm i$ 10.4 $\pm2,\ \ \pm 2i$
10.5 $\pm1,\ (\pm1\pm i\sqrt{3})/2$ 10.6 $\pm2,\ \pm1\pm i\sqrt{3}$
10.7 $\pm\sqrt{2},\ \pm i\sqrt{2},\ \pm1\pm i$ 10.8 $\pm1,\ \pm i,\ (\pm1\pm i)/\sqrt{2}$
10.9 $1,\ 0.309\pm0.951i,\ -0.809\pm0.588i$
10.10 $2,\ 0.618\pm1.902i,\ -1.618\pm1.176i$
10.11 $-2,\ 1\pm i\sqrt{3}$ 10.12 $-1,\ \left(1\pm i\sqrt{3}\right)/2$
10.13 $\pm1\pm i$ 10.14 $(\pm1\pm i)/\sqrt{2}$
10.15 $\pm2i,\ \pm\sqrt{3}\pm i$ 10.16 $\pm i,\ (\pm\sqrt{3}\pm i)/2$
10.17 $-1,\ 0.809\pm0.588i,\ -0.309\pm0.951i$
10.18 $\pm(1+i)/\sqrt{2}$ 10.19 $-i,\ (\pm\sqrt{3}+i)/2$
10.20 $2i,\ \pm\sqrt{3}-i$ 10.21 $\pm(\sqrt{3}+i)$
10.22 $r=\sqrt{2},\ \theta=45^\circ+120^\circ n$: $1+i,\ -1.366+0.366i,\ 0.366-1.366i$
10.23 $r=2,\ \theta=30^\circ+90^\circ n$: $\pm(\sqrt{3}+i),\ \pm\left(1-i\sqrt{3}\right)$
10.24 $r=1,\ \theta=30^\circ+45^\circ n$:
$\pm(\sqrt{3}+i)/2,\ \pm\left(1-i\sqrt{3}\right)/2,\quad \pm(0.259+0966i),\ \pm(0.966-0.259i)$
10.25 $r=\sqrt[10]{2},\ \theta=45^\circ+72^\circ n$: $0.758(1+i),\ -0.487+0.955i,$
$-1.059-0.168i,\ -0.168-1.059i,\ 0.955-0.487i$
10.26 $r=1,\ \theta=18^\circ+72^\circ n:\ i,\ \pm0.951+0.309i,\ \pm0.588-0.809i$
10.28 $\cos3\theta=\cos^3\theta-3\cos\theta\sin^2\theta$
$\sin3\theta=3\cos^2\theta\sin\theta-\sin^3\theta$

11.3	$3(1-i)/\sqrt{2}$	11.4	-8	11.5	$1+i$	11.6	$13/5$
11.7	$3i/5$	11.8	$-41/9$	11.9	$4i/3$	11.10	-1

12.20 $\cosh3z=\cosh^3z+3\cosh z\sinh^2z,\quad \sinh3z=3\cosh^2z\sinh z+\sinh^3z$
12.22 $\sinh x=\displaystyle\sum_{n=0}^{\infty}\frac{x^{2n+1}}{(2n+1)!}\ ,\quad \cosh x=\sum_{n=0}^{\infty}\frac{x^{2n}}{(2n)!}$
12.23 $\cos x,\ |\cos x|$
12.24 $\cosh x$
12.25 $\sin x\cosh y-i\cos x\sinh y,\quad \sqrt{\sin^2x+\sinh^2y}$
12.26 $\cosh2\cos3-i\sinh2\sin3=-3.725-0.512i,\ 3.760$
12.27 $\sin4\cosh3+i\cos4\sinh3=-7.62-6.55i,\ 10.05$
12.28 $\tanh1=0.762$ 12.29 1
12.30 $-i$ 12.31 $(3+5i\sqrt{3})/8$
12.32 $-4i/3$ 12.33 $i\tanh1=0.762i$
12.34 $i\sinh(\pi/2)=2.301i$ 12.35 $-\cosh2=-3.76$
12.36 $i\cosh1=1.543i$ 12.37 $\cosh\pi$

14.1 $1 + i\pi$ 14.2 $-i\pi/2$ or $3\pi i/2$
14.3 $\text{Ln}\,2 + i\pi/6$ 14.4 $(1/2)\,\text{Ln}\,2 + 3\pi i/4$
14.5 $\text{Ln}\,2 + 5i\pi/4$ 14.6 $-i\pi/4$ or $7\pi i/4$
14.7 $i\pi/2$ 14.8 -1, $(1 \pm i\sqrt{3})/2$
14.9 $e^{-\pi}$ 14.10 $e^{-\pi^2/4}$
14.11 $\cos(\text{Ln}\,2) + i\sin(\text{Ln}\,2) = 0.769 + 0.639i$
14.12 $-ie^{-\pi/2}$
14.13 $1/e$
14.14 $2e^{-\pi/2}[i\cos(\text{Ln}\,2) - \sin(\text{Ln}\,2)] = 0.3198i - 0.2657$
14.15 $e^{-\pi\sinh 1} = 0.0249$
14.16 $e^{-\pi/3} = 0.351$
14.17 $\sqrt{2}\, e^{-3\pi/4}e^{i(\text{Ln}\sqrt{2}+3\pi/4)} = -0.121 + 0.057i$
14.18 -1 14.19 $-5/4$
14.20 1 14.21 -1
14.22 $-1/2$ 14.23 $e^{\pi/2} = 4.81$

15.1 $\pi/2 + 2n\pi \pm i\,\text{Ln}\left(2+\sqrt{3}\right) = \pi/2 + 2n\pi \pm 1.317i$
15.2 $\pi/2 + n\pi + (i\,\text{Ln}\,3)/2$
15.3 $i(\pm\pi/3 + 2n\pi)$
15.4 $i(2n\pi + \pi/6)$, $i(2n\pi + 5\pi/6)$
15.5 $\pm\left[\pi/2 + 2n\pi - i\,\text{Ln}\left(3+\sqrt{8}\right)\right] = \pm[\pi/2 + 2n\pi - 1.76i]$
15.6 $i(n\pi - \pi/4)$
15.7 $\pi/2 + n\pi - i\,\text{Ln}(\sqrt{2}-1) = \pi/2 + n\pi + 0.881i$
15.8 $\pi/2 + 2n\pi \pm i\,\text{Ln}\,3$
15.9 $i(\pi/3 + n\pi)$
15.10 $2n\pi \pm i\,\text{Ln}\,2$
15.11 $i(2n\pi + \pi/4)$, $i(2n\pi + 3\pi/4)$
15.12 $i(2n\pi \pm \pi/6)$
15.13 $i(\pi + 2n\pi)$
15.14 $2n\pi + i\,\text{Ln}\,2$, $(2n+1)\pi - i\,\text{Ln}\,2$
15.15 $n\pi + 3\pi/8 + i\,\text{Ln}\,2)/4$
15.16 $(\text{Ln}\,2)/4 + i(n\pi + 5\pi/8)$

16.2 Motion around circle $|z| = 5$; $v = 5\omega$, $a = 5\omega^2$.
16.3 Motion around circle $|z| = \sqrt{2}$; $v = \sqrt{2}$, $a = \sqrt{2}$.
16.4 $v = \sqrt{13}$, $a = 0$
16.5 $v = |z_1 - z_2|$, $a = 0$
16.6 (a) Series: $3 - 2i$ (b) Series: $2(1 + i\sqrt{3})$
Parallel: $5 + i$ Parallel: $i\sqrt{3}$
16.7 (a) Series: $1 + 2i$ (b) Series: $5 + 5i$
Parallel: $3(3-i)/5$ Parallel: $1.6 + 1.2i$
16.8 $\left[R - i(\omega CR^2 + \omega^3L^2C - \omega L)\right] / \left[(\omega CR)^2 + (\omega^2LC - 1)^2\right]$; this simplifies to $\dfrac{L}{RC}$ if $\omega^2 = \dfrac{1}{LC}\left(1 - \dfrac{R^2C}{L}\right)$, that is, at resonance.
16.9 (a) $\omega = \dfrac{R}{2L} \pm \sqrt{\dfrac{R^2}{4L^2} + \dfrac{1}{LC}}$ (b) $\omega = 1/\sqrt{LC}$
16.10 (a) $\omega = -\dfrac{1}{2RC} \pm \sqrt{\dfrac{1}{4R^2C^2} + \dfrac{1}{LC}}$ (b) $\omega = 1/\sqrt{LC}$
16.12 $(1 + r^4 - 2r^2\cos\theta)^{-1}$

17.1 -1

17.2 $(\sqrt{3}+i)/2$

17.3 $r=\sqrt{2}$, $\theta = 45^\circ + 72^\circ n : 1+i,\ -0.642+1.260i,\ -1.397-0.221i,$
$-0.221-1.397i,\ 1.260-0.642i$

17.4 $i\cosh 1 = 1.54i$

17.5 i

17.6 $-e^{-\pi^2} = -5.17\times 10^{-5}$ or $-e^{-\pi^2}\cdot e^{\pm 2n\pi^2}$

17.7 $e^{\pi/2} = 4.81$ or $e^{\pi/2}\cdot e^{\pm 2n\pi}$

17.8 -1

17.9 $\pi/2 \pm 2n\pi$

17.10 $\sqrt{3}-2$

17.11 i

17.12 $-1\pm\sqrt{2}$

17.13 $x=0,\ y=4$

17.14 Circle with center $(0,\ 2)$, radius 1

17.15 $|z| < 1/e$

17.16 $y < -2$

17.26 1

17.27 (c) $e^{-2(x-t)^2}$

17.28 $1+\left[\dfrac{a^2+b^2}{2ab}\right]^2 \sinh^2 b$

17.29 $\left(-1\pm i\sqrt{3}\right)/2$

17.30
$$e^x\cos x = \sum_{\text{n=0}}^{\infty} \frac{x^n 2^{n/2}\cos n\pi/4}{n!}$$
$$e^x\sin x = \sum_{\text{n=0}}^{\infty} \frac{x^n 2^{n/2}\sin n\pi/4}{n!}$$

Chapter 3

2.3 $\begin{pmatrix}1 & 0 & -3\\ 0 & 1 & 5\end{pmatrix}$, $x=-3$, $y=5)$

2.4 $\begin{pmatrix}1 & 0 & -1/2 & 1/2\\ 0 & 1 & 0 & 1\end{pmatrix}$, $x=(z+1)/2$, $y=1$

2.5 $\begin{pmatrix}1 & 1/2 & -1/2 & 0\\ 0 & 0 & 0 & 1\end{pmatrix}$, no solution

2.6 $\begin{pmatrix}1 & 0 & 0 & 1\\ 0 & 1 & -1 & 0\end{pmatrix}$, $x=1$, $z=y$

2.7 $\begin{pmatrix}1 & 0 & -4\\ 0 & 1 & 3\\ 0 & 0 & 0\end{pmatrix}$, $x=-4$, $y=3$

2.8 $\begin{pmatrix}1 & -1 & 0 & -11\\ 0 & 0 & 1 & 7\\ 0 & 0 & 0 & 0\end{pmatrix}$, $x=y-11$, $z=7$

2.9 $\begin{pmatrix}1 & 0 & 1 & 0\\ 0 & 1 & -1 & 0\\ 0 & 0 & 0 & 1\end{pmatrix}$, inconsistent, no solution

2.10 $\begin{pmatrix}1 & 0 & -1 & 0\\ 0 & 1 & 0 & 0\\ 0 & 0 & 0 & 1\end{pmatrix}$, inconsistent, no solution

2.11 $\begin{pmatrix}1 & 0 & 0 & 2\\ 0 & 1 & 0 & -1\\ 0 & 0 & 1 & -3\end{pmatrix}$, $x=2$, $y=-1$, $z=-3$

2.12 $\begin{pmatrix}1 & 0 & 0 & -2\\ 0 & 1 & 0 & 1\\ 0 & 0 & 1 & 1\end{pmatrix}$, $x=-2$, $y=1$, $z=1$

2.13 $\begin{pmatrix}1 & 0 & 0 & -2\\ 0 & 1 & -2 & 5/2\\ 0 & 0 & 0 & 0\end{pmatrix}$, $x=-2$, $y=2z+5/2$

2.14 $\begin{pmatrix}1 & 0 & 1 & 0\\ 0 & 1 & -1 & 0\\ 0 & 0 & 0 & 1\end{pmatrix}$, inconsistent, no solution

2.15	$R = 2$			2.16	$R = 3$		
2.17	$R = 2$			2.18	$R = 3$		

3.1	-11	3.2	-721	3.3	1	3.4	2140
3.5	-544	3.6	4	3.11	0	3.12	16

3.16 $A = -(K + ik)/(K - ik)$, $|A| = 1$
3.17 $x = \gamma(x' + vt')$, $t = \gamma(t' + vx'/c^2)$
3.18 $D = 3b(a + b)(a^2 + ab + b^2)$, $z = 1$
(Also $x = a + 2b$, $y = a - b$; these were not required.)

4.11 $-3\mathbf{i} + 8\mathbf{j} - 6\mathbf{k}$, $\mathbf{i} - 10\mathbf{j} + 3\mathbf{k}$, $2\mathbf{i} + 2\mathbf{j} + 3\mathbf{k}$.
4.12 $\arccos(-1/\sqrt{2}) = 3\pi/4$
4.13 $-5/3$, -1, $\cos\theta = -1/3$
4.14 (a) $\arccos(1/3) = 70.5°$
(b) $\arccos(1/\sqrt{3}) = 54.7°$
(c) $\arccos\sqrt{2/3} = 35.3°$
4.15 (a) $(2\mathbf{i} - \mathbf{j} + 2\mathbf{k})/3$
(b) $8\mathbf{i} - 4\mathbf{j} + 8\mathbf{k}$
(c) Any combination of $\mathbf{i} + 2\mathbf{j}$ and $\mathbf{i} - \mathbf{k}$.
(d) Answer to (c) divided by its magnitude.
4.17 Legs = any two vectors with dot product = 0;
hypotenuse = their sum (or difference).

4.18	$2\mathbf{i} - 8\mathbf{j} - 3\mathbf{k}$	4.19	$\mathbf{i} + \mathbf{j} + \mathbf{k}$
4.20	$2\mathbf{i} - 2\mathbf{j} + \mathbf{k}$	4.22	Law of cosines
4.24	A^2B^2		

In the following answers, note that the point and vector used may be *any* point on the line and *any* vector along the line.

5.1	$\mathbf{r} = (2, -3) + (4, 3)t$	5.2	$3/2$
5.3	$\mathbf{r} = (3, 0) + (1, 1)t$	5.4	$\mathbf{r} = (1, 0) + (2, 1)t$
5.5	$\mathbf{r} = \mathbf{j}\,t$		

5.6 $\frac{x-1}{1} = \frac{y+1}{-2} = \frac{z+5}{2}$; $\mathbf{r} = (1, -1, -5) + (1, -2, 2)t$
5.7 $\frac{x-2}{3} = \frac{y-3}{-2} = \frac{z-4}{-6}$; $\mathbf{r} = (2, 3, 4) + (3, -2, -6)t$
5.8 $\frac{x}{3} = \frac{z-4}{-5}$, $y = -2$; $\mathbf{r} = (0, -2, 4) + (3, 0, -5)t$
5.9 $x = -1$, $z = 7$; $\mathbf{r} = -\mathbf{i} + 7\mathbf{k} + \mathbf{j}t$
5.10 $\frac{x-3}{2} = \frac{y-4}{-3} = \frac{z+1}{6}$; $\mathbf{r} = (3, 4, -1) + (2, -3, 6)t$
5.11 $\frac{x-4}{1} = \frac{z-3}{-2}$, $y = -1$; $\mathbf{r} = (4, -1, 3) + (1, 0, -2)t$
5.12 $\frac{x-5}{5} = \frac{y+4}{-2} = \frac{z-2}{1}$; $\mathbf{r} = (5, -4, 2) + (5, -2, 1)t$
5.13 $x = 3$, $\frac{y}{-3} = \frac{z+5}{1}$; $\mathbf{r} = 3\mathbf{i} - 5\mathbf{k} + (-3\mathbf{j} + \mathbf{k})t$

5.14	$36x - 3y - 22z = 23$	5.15	$5x + 6y + 3z = 0$
5.16	$5x - 2y + z = 35$	5.17	$3y - z = 5$
5.18	$x + 6y + 7z + 5 = 0$	5.19	$x + y + 3z + 12 = 0$
5.20	$x - 4y - z + 5 = 0$		

5.21 $\cos\theta = 25/\left(7\sqrt{30}\right) = 0.652$, $\theta = 49.3°$
5.22 $\cos\theta = 2/\sqrt{6}$, $\theta = 35.3°$
5.23 $\cos\theta = 4/21$, $\theta = 79°$
5.24 $\mathbf{r} = 2\mathbf{i} + \mathbf{j} + (\mathbf{j} + 2\mathbf{k})t$, $d = 2\sqrt{6/5}$
5.25 $\mathbf{r} = (1, -2, 0) + (4, 9, -1)t$, $d = \left(3\sqrt{3}\right)/7$
5.26 $\mathbf{r} = (8, 1, 7) + (14, 2, 15)t$, $d = \sqrt{2/17}$

5.27	$y + 2z + 1 = 0$	5.28	$4x + 9y - z + 27 = 0$
5.29	$2/\sqrt{6}$	5.30	1
5.31	$5/7$	5.32	$10/\sqrt{27}$

5.33 $\sqrt{43/15}$

5.34 $\sqrt{11/10}$

5.35 $\sqrt{5}$

5.36 3

5.37 Intersect at $(1,-3,4)$

5.38 $\arccos\sqrt{21/22} = 12.3°$

5.39 $t_1 = 1$, $t_2 = -2$, intersect at $(3,2,0)$, $\cos\theta = 5/\sqrt{60}$, $\theta = 49.8°$

5.40 $t_1 = -1$, $t_2 = 1$, intersect at $(4,-1,1)$, $\cos\theta = 5/\sqrt{39}$, $\theta = 36.8°$

5.41 $\sqrt{14}$

5.42 $1/\sqrt{5}$

5.43 $20/\sqrt{21}$

5.44 $2/\sqrt{10}$

5.45 $d = \sqrt{2}$, $t = -1$

6.1 $\mathrm{AB} = \begin{pmatrix} -5 & 10 \\ 1 & 24 \end{pmatrix}$ $\quad \mathrm{BA} = \begin{pmatrix} -2 & 8 \\ 11 & 21 \end{pmatrix}$ $\quad \mathrm{A+B} = \begin{pmatrix} 1 & 3 \\ 3 & 9 \end{pmatrix}$

$\mathrm{A-B} = \begin{pmatrix} 5 & -1 \\ 1 & 1 \end{pmatrix}$ $\quad \mathrm{A}^2 = \begin{pmatrix} 11 & 8 \\ 16 & 27 \end{pmatrix}$ $\quad \mathrm{B}^2 = \begin{pmatrix} 6 & 4 \\ 2 & 18 \end{pmatrix}$

$5\mathrm{A} = \begin{pmatrix} 15 & 5 \\ 10 & 25 \end{pmatrix}$ $\quad 3\mathrm{B} = \begin{pmatrix} -6 & 6 \\ 3 & 12 \end{pmatrix}$ $\quad \det(5\mathrm{A}) = 5^2 \det \mathrm{A}$

6.2 $\mathrm{AB} = \begin{pmatrix} -2 & -2 \\ 1 & 2 \end{pmatrix}$ $\quad \mathrm{BA} = \begin{pmatrix} -6 & 17 \\ -2 & 6 \end{pmatrix}$ $\quad \mathrm{A+B} = \begin{pmatrix} 1 & -1 \\ -1 & 5 \end{pmatrix}$

$\mathrm{A-B} = \begin{pmatrix} 3 & -9 \\ -1 & 1 \end{pmatrix}$ $\quad \mathrm{A}^2 = \begin{pmatrix} 9 & -25 \\ -5 & 14 \end{pmatrix}$ $\quad \mathrm{B}^2 = \begin{pmatrix} 1 & 4 \\ 0 & 4 \end{pmatrix}$

$5\mathrm{A} = \begin{pmatrix} 10 & -25 \\ -5 & 15 \end{pmatrix}$ $\quad 3\mathrm{B} = \begin{pmatrix} -3 & 12 \\ 0 & 6 \end{pmatrix}$

6.3 $\mathrm{AB} = \begin{pmatrix} 7 & -1 & 0 \\ 3 & 1 & -1 \\ 3 & 9 & 5 \end{pmatrix}$ $\quad \mathrm{BA} = \begin{pmatrix} 4 & -1 & 2 \\ 6 & 3 & 1 \\ 0 & 1 & 6 \end{pmatrix}$ $\quad \mathrm{A+B} = \begin{pmatrix} 2 & 1 & 2 \\ 3 & 1 & 1 \\ 3 & 4 & 1 \end{pmatrix}$

$\mathrm{A-B} = \begin{pmatrix} 0 & -1 & 2 \\ 3 & -3 & -1 \\ -3 & 6 & 1 \end{pmatrix}$ $\quad \mathrm{A}^2 = \begin{pmatrix} 1 & 10 & 4 \\ 0 & 1 & 6 \\ 15 & 0 & 1 \end{pmatrix}$ $\quad \mathrm{B}^2 = \begin{pmatrix} 1 & 3 & 1 \\ 3 & 3 & 2 \\ 3 & 1 & -1 \end{pmatrix}$

$5\mathrm{A} = \begin{pmatrix} 5 & 0 & 10 \\ 15 & -5 & 0 \\ 0 & 25 & 5 \end{pmatrix}$ $\quad 3\mathrm{B} = \begin{pmatrix} 3 & 3 & 0 \\ 0 & 6 & 3 \\ 9 & -3 & 0 \end{pmatrix}$ $\quad \det(5\mathrm{A}) = 5^3 \det \mathrm{A}$

6.4 $\mathrm{BA} = \begin{pmatrix} 12 & 10 & 2 & 12 \\ 0 & 2 & 1 & -9 \\ 4 & 8 & 3 & -17 \end{pmatrix}$ $\quad \mathrm{C}^2 = \begin{pmatrix} 5 & 1 & 7 \\ 6 & 5 & 12 \\ -3 & -1 & -2 \end{pmatrix}$

$\mathrm{CB} = \begin{pmatrix} 14 & 4 \\ 1 & 19 \\ 1 & -5 \end{pmatrix}$ $\quad \mathrm{C}^3 = \begin{pmatrix} 7 & 4 & 20 \\ 20 & 1 & 20 \\ -8 & -2 & -9 \end{pmatrix}$

$\mathrm{C}^2 B = \begin{pmatrix} 32 & 12 \\ 53 & 7 \\ -13 & -9 \end{pmatrix}$ $\quad \mathrm{CBA} = \begin{pmatrix} 36 & 46 & 14 & -36 \\ 40 & 22 & 1 & 91 \\ -8 & -2 & 1 & -29 \end{pmatrix}$

6.5 $\mathrm{AA}^{\mathrm{T}} = \begin{pmatrix} 30 & -13 \\ -13 & 30 \end{pmatrix}$ $\quad \mathrm{A}^{\mathrm{T}}\mathrm{A} = \begin{pmatrix} 8 & 8 & 2 & 2 \\ 8 & 10 & 3 & -7 \\ 2 & 3 & 1 & -4 \\ 2 & -7 & -4 & 41 \end{pmatrix}$

$\mathrm{BB}^{\mathrm{T}} = \begin{pmatrix} 20 & -2 & 2 \\ -2 & 2 & 4 \\ 2 & 4 & 10 \end{pmatrix}$ $\quad \mathrm{B}^{\mathrm{T}} B = \begin{pmatrix} 14 & 4 \\ 4 & 18 \end{pmatrix}$

$\mathrm{CC}^{\mathrm{T}} = \begin{pmatrix} 14 & 1 & 1 \\ 1 & 21 & -6 \\ 1 & -6 & 2 \end{pmatrix}$ $\quad \mathrm{C}^{\mathrm{T}}\mathrm{C} = \begin{pmatrix} 21 & -2 & -3 \\ -2 & 2 & 5 \\ -3 & 5 & 14 \end{pmatrix}$

6.8 $5x^2 + 3y^2 = 30$

6.9 $\mathrm{AB} = \begin{pmatrix} 0 & 0 \\ 0 & 0 \end{pmatrix} \qquad \mathrm{BA} = \begin{pmatrix} 22 & 44 \\ -11 & -22 \end{pmatrix}$

6.10 $\mathrm{AC} = \mathrm{A\,D} = \begin{pmatrix} 11 & 12 \\ 33 & 36 \end{pmatrix}$

6.13 $\begin{pmatrix} 5/3 & -3 \\ -1 & 2 \end{pmatrix}$

6.14 $\frac{1}{6}\begin{pmatrix} 3 & 1 \\ 0 & -2 \end{pmatrix}$

6.15 $-\frac{1}{2}\begin{pmatrix} 4 & 5 & 8 \\ -2 & -2 & -2 \\ 2 & 3 & 4 \end{pmatrix}$

6.16 $\frac{1}{8}\begin{pmatrix} -2 & 1 & 1 \\ 6 & -3 & 5 \\ 4 & 2 & 2 \end{pmatrix}$

6.17 $\mathrm{A}^{-1} = \frac{1}{6}\begin{pmatrix} 2 & 2 & -1 \\ 4 & 4 & -5 \\ 8 & 2 & -4 \end{pmatrix} \qquad \mathrm{B}^{-1} = \begin{pmatrix} 1 & 1 & -1 \\ -2 & 0 & 1 \\ 0 & -1 & 1 \end{pmatrix}$

$\mathrm{B}^{-1}\mathrm{AB} = \begin{pmatrix} 3 & 1 & 2 \\ -2 & -2 & -2 \\ -2 & -1 & 0 \end{pmatrix} \qquad \mathrm{B}^{-1}\mathrm{A}^{-1}\mathrm{B} = \frac{1}{6}\begin{pmatrix} 2 & 2 & -2 \\ -4 & -4 & -2 \\ 2 & -1 & 4 \end{pmatrix}$

6.19 $\mathrm{A}^{-1} = \frac{1}{7}\begin{pmatrix} 1 & 2 \\ -3 & -1 \end{pmatrix}, \quad (x, y) = (5, 0)$

6.20 $\mathrm{A}^{-1} = \frac{1}{7}\begin{pmatrix} -4 & 3 \\ 5 & -2 \end{pmatrix}, \quad (x, y) = (4, -3)$

6.21 $\mathrm{A}^{-1} = \frac{1}{5}\begin{pmatrix} -1 & 2 & 2 \\ -2 & -1 & 4 \\ 3 & -1 & -1 \end{pmatrix}, \quad (x, y, z) = (-2, 1, 5)$

6.22 $\mathrm{A}^{-1} = \frac{1}{12}\begin{pmatrix} 4 & 4 & 0 \\ -7 & -1 & 3 \\ 1 & -5 & 3 \end{pmatrix}, \quad (x, y, z) = (1, -1, 2)$

6.30 $\sin k\mathrm{A} = \mathrm{A}\sin k = \begin{pmatrix} 0 & \sin k \\ \sin k & 0 \end{pmatrix}, \ \cos k\mathrm{A} = \mathrm{I}\cos k = \begin{pmatrix} \cos k & 0 \\ 0 & \cos k \end{pmatrix},$

$e^{k\mathrm{A}} = \begin{pmatrix} \cosh k & \sinh k \\ \sinh k & \cosh k \end{pmatrix}, \quad e^{ik\mathrm{A}} = \begin{pmatrix} \cos k & i\sin k \\ i\sin k & \cos k \end{pmatrix}$

6.32 $e^{i\theta\mathrm{B}} = \begin{pmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \end{pmatrix}$

In the following, L = linear, N = not linear.

7.1	N	7.2	L	7.3	N	7.4	L	7.5	L
7.6	N	7.7	L	7.8	N	7.9	N	7.10	N
7.11	N	7.12	L	7.13	(a) L	(b) L			
7.14	N	7.15	L	7.16	N	7.17	N		

7.22 $D = 1$, rotation $\theta = -45°$ 7.23 $D = 1$, rotation $\theta = 210°$

7.24 $D = -1$, reflection line $x + y = 0$ 7.25 $D = -1$, reflection line $y = x\sqrt{2}$

7.26 $D = -1$, reflection line $x = 2y$ 7.27 $D = 1$, rotation $\theta = 135°$

7.28 $\begin{pmatrix} 1 & 0 & 0 \\ 0 & \cos\theta & -\sin\theta \\ 0 & \sin\theta & \cos\theta \end{pmatrix}, \qquad \begin{pmatrix} -1 & 0 & 0 \\ 0 & \cos\theta & -\sin\theta \\ 0 & \sin\theta & \cos\theta \end{pmatrix}$

7.29 $\begin{pmatrix} 0 & 0 & 1 \\ 0 & -1 & 0 \\ -1 & 0 & 0 \end{pmatrix}$

7.30 $\mathrm{R}=\begin{pmatrix}0&-1&0\\1&0&0\\0&0&1\end{pmatrix}$, $\mathrm{S}=\begin{pmatrix}1&0&0\\0&0&-1\\0&1&0\end{pmatrix}$; R is a 90° rotation about the z axis; S is a 90° rotation about the x axis.

7.31 From problem 30, $\mathrm{RS}=\begin{pmatrix}0&0&1\\1&0&0\\0&1&0\end{pmatrix}$, $\mathrm{SR}=\begin{pmatrix}0&-1&0\\0&0&-1\\1&0&0\end{pmatrix}$; RS is a 120° rotation about $\mathbf{i}+\mathbf{j}+\mathbf{k}$; SR is a 120° rotation about $\mathbf{i}-\mathbf{j}+\mathbf{k}$.

7.32 180° rotation about $\mathbf{i}-\mathbf{k}$

7.33 120° rotation about $\mathbf{i}-\mathbf{j}-\mathbf{k}$

7.34 Reflection through the plane $y+z=0$

7.35 Reflection through the (x,y) plane, and 90° rotation about the z axis.

8.1 In terms of basis $\mathbf{u}=\frac{1}{9}(9,0,7)$, $\mathbf{v}=\frac{1}{9}(0,-9,13)$, the vectors are: $\mathbf{u}-4\mathbf{v}$, $5\mathbf{u}-2\mathbf{v}$, $2\mathbf{u}+\mathbf{v}$, $3\mathbf{u}+6\mathbf{v}$.

8.2 In terms of basis $\mathbf{u}=\frac{1}{3}(3,0,5)$, $\mathbf{v}=\frac{1}{3}(0,3,-2)$, the vectors are: $\mathbf{u}-2\mathbf{v}$, $\mathbf{u}+\mathbf{v}$, $-2\mathbf{u}+\mathbf{v}$, $3\mathbf{u}$.

8.3 Basis $\mathbf{i}$, $\mathbf{j}$, $\mathbf{k}$.

8.4 Basis $\mathbf{i}$, $\mathbf{j}$, $\mathbf{k}$.

8.6 $\mathbf{V}=3\mathbf{A}-\mathbf{B}$

8.7 $\mathbf{V}=\frac{3}{2}(1,-4)+\frac{1}{2}(5,2)$

8.17 $x=0$, $y=\frac{3}{2}z$

8.18 $x=-3y$, $z=2y$

8.19 $x=y=z=w=0$

8.20 $x=-z$, $y=z$

8.21 $\begin{pmatrix}x_1&y_1&z_1&1\\x_2&y_2&z_2&1\\x_3&y_3&z_3&1\\x_4&y_4&z_4&1\end{pmatrix}=0$

8.22 $\begin{pmatrix}a_1&b_1&c_1\\a_2&b_2&c_2\\a_3&b_3&c_3\end{pmatrix}=0$

8.23 For $\lambda=3$, $x=2y$; for $\lambda=8$, $y=-2x$

8.24 For $\lambda=7$, $x=3y$; for $\lambda=-3$, $y=-3x$

8.25 For $\lambda=2$: $x=0$, $y=-3z$; for $\lambda=-3$: $x=-5y$, $z=3y$; .
for $\lambda=4$: $z=3y$, $x=2y$

8.26 $\mathbf{r}=(3,1,0)+(-1,1,1)z$

8.27 $\mathbf{r}=(0,1,2)+(1,1,0)x$

8.28 $\mathbf{r}=(3,1,0)+(2,1,1)z$

9.3 $\mathrm{A}^\dagger=\begin{pmatrix}1&2i&1\\0&2&1-i\\-5i&0&0\end{pmatrix}$, $\mathrm{A}^{-1}=\dfrac{1}{10}\begin{pmatrix}0&5i-5&-10i\\0&-5i&10\\-2i&-1-i&2\end{pmatrix}$

9.4 $\mathrm{A}^\dagger=\begin{pmatrix}0&i&3\\-2i&2&0\\-1&0&0\end{pmatrix}$, $\mathrm{A}^{-1}=\dfrac{1}{6}\begin{pmatrix}0&0&2\\0&3&i\\-6&6i&-2\end{pmatrix}$

9.14 $\mathrm{C^TBA^T}$, $\mathrm{C^{-1}M^{-1}C}$, H

10.1 (a) $d=5$ (b) $d=8$ (c) $d=\sqrt{56}$

10.2 The dimension of the space = the number of basis vectors listed. One possible basis is given; other bases consist of the same number of independent linear combinations of the vectors given.
(a) $(1,-1,0,0)$, $(-2,0,5,1)$
(b) $(1,0,0,5,0,1)$, $(0,1,0,0,6,4)$, $(0,0,1,0,-3,0)$
(c) $(1,0,0,0,-3)$, $(0,2,0,0,1)$, $(0,0,1,0,-1)$, $(0,0,0,1,4)$

10.3 (a) Label the vectors $\mathbf{A}$, $\mathbf{B}$, $\mathbf{C}$, $\mathbf{D}$. Then $\cos(\mathbf{A},\mathbf{B}) = \frac{1}{\sqrt{15}}$,
$\cos(\mathbf{A},\mathbf{C}) = \frac{\sqrt{2}}{3}$, $\cos(\mathbf{A},\mathbf{D}) = \frac{3}{\sqrt{23}}$, $\cos(\mathbf{B},\mathbf{C}) = \frac{2}{3\sqrt{15}}$,
$\cos(\mathbf{B},\mathbf{D}) = \sqrt{\frac{17}{690}}$, $\cos(\mathbf{C},\mathbf{D}) = \frac{\sqrt{21}}{6\sqrt{23}}$.
(b) $(1,0,0,5,0,1)$ and $(0,0,1,0,-3,0)$

10.4 (a) $\mathbf{e}_1 = (0,1,0,0)$, $\mathbf{e}_2 = (1,0,0,0)$, $\mathbf{e}_3 = (0,0,3,4)/5$
(b) $\mathbf{e}_1 = (0,0,0,1)$, $\mathbf{e}_2 = (1,0,0,0)$, $\mathbf{e}_3 = (0,1,1,0)/\sqrt{2}$
(c) $\mathbf{e}_1 = (1,0,0,0)$, $\mathbf{e}_2 = (0,0,1,0)$, $\mathbf{e}_3 = (0,1,0,2)/\sqrt{5}$

10.5 (a) $\|\mathbf{A}\| = \sqrt{43}$, $\|\mathbf{B}\| = \sqrt{41}$, $|\text{Inner product of } \mathbf{A} \text{ and } \mathbf{B}| = \sqrt{74}$
(b) $\|\mathbf{A}\| = 7$, $\|\mathbf{B}\| = \sqrt{60}$, $|\text{Inner product of } \mathbf{A} \text{ and } \mathbf{B}| = \sqrt{5}$

11.5 $\theta = 1.1 = 63.4^\circ$

11.11 $\begin{pmatrix} x \\ y \end{pmatrix} = \frac{1}{5}\begin{pmatrix} 1 & 3 \\ -1 & 2 \end{pmatrix}\begin{pmatrix} x' \\ y' \end{pmatrix}$, not orthogonal

In the following answers, for each eigenvalue, the components of a corresponding eigenvector are listed in parentheses.

11.12	4	$(1,1)$
	-1	$(3,-2)$
11.13	3	$(2,1)$
	-2	$(-1,2)$
11.14	4	$(2,-1)$
	-1	$(1,2)$
11.15	1	$(0,0,1)$
	-1	$(1,-1,0)$
	5	$(1,1,0)$
11.16	2	$(0,1,0)$
	3	$(2,0,1)$
	-2	$(1,0,-2)$
11.17	7	$(1,0,1)$
	3	$(1,0,-1)$
	3	$(0,1,0)$
11.18	4	$(2,1,3)$
	2	$(0,-3,1)$
	-3	$(5,-1,-3)$
11.19	3	$(0,1,-1)$
	5	$(1,1,1)$
	-1	$(2,-1,-1)$
11.20	3	$(0,-1,2)$
	4	$(1,2,1)$
	-2	$(-5,2,1)$
11.21	-1	$(-1,1,1)$
	2	$(2,1,1)$
	-2	$(0,-1,1)$
11.22	-4	$(-4,1,1)$
	5	$(1,2,2)$
	-2	$(0,-1,1)$
11.23	18	(2,2,-1)
	9	Any two vectors orthogonal to (2,2,-1) and to each
	9	other, for example: (1,-1,0) and (1,1,4)
11.24	8	(2,1,2)
	-1	Any two vectors orthogonal to (2,1,2) and to each
	-1	other, for example: (1,0,-1) and (1,-4,1)
11.25	1	$(-1,1,1)$
	2	$(1,1,0)$
	-2	$(1,-1,2)$
11.26	4	(1,1,1)
	1	Any two vectors orthogonal to (1,1,1) and to each
	1	other, for example: (1,-1,0) and (1,1,-2)

11.27 $\mathrm{D} = \begin{pmatrix} 3 & 0 \\ 0 & 1 \end{pmatrix}$, $\mathrm{C} = \frac{1}{\sqrt{2}}\begin{pmatrix} 1 & 1 \\ -1 & 1 \end{pmatrix}$

11.28 $\mathrm{D} = \begin{pmatrix} 1 & 0 \\ 0 & 6 \end{pmatrix}$, $\mathrm{C} = \frac{1}{\sqrt{5}}\begin{pmatrix} 1 & 2 \\ -2 & 1 \end{pmatrix}$

11.29 $D = \begin{pmatrix} 11 & 0 \\ 0 & 1 \end{pmatrix}$, $C = \dfrac{1}{\sqrt{5}} \begin{pmatrix} 1 & -2 \\ 2 & 1 \end{pmatrix}$

11.30 $D = \begin{pmatrix} 4 & 0 \\ 0 & 2 \end{pmatrix}$, $C = \dfrac{1}{\sqrt{2}} \begin{pmatrix} 1 & -1 \\ 1 & 1 \end{pmatrix}$

11.31 $D = \begin{pmatrix} 5 & 0 \\ 0 & 1 \end{pmatrix}$, $C = \dfrac{1}{\sqrt{2}} \begin{pmatrix} 1 & -1 \\ 1 & 1 \end{pmatrix}$

11.32 $D = \begin{pmatrix} 7 & 0 \\ 0 & 2 \end{pmatrix}$, $C = \dfrac{1}{\sqrt{5}} \begin{pmatrix} 2 & 1 \\ -1 & 2 \end{pmatrix}$

11.41 $\lambda = 1,\ 3;\quad U = \dfrac{1}{\sqrt{2}} \begin{pmatrix} 1 & i \\ i & 1 \end{pmatrix}$

11.42 $\lambda = 1,\ 4;\quad U = \dfrac{1}{\sqrt{3}} \begin{pmatrix} 1 & 1-i \\ -1-i & 1 \end{pmatrix}$

11.43 $\lambda = 2,\ -3;\quad U = \dfrac{1}{\sqrt{5}} \begin{pmatrix} 2 & -i \\ -i & 2 \end{pmatrix}$

11.44 $\lambda = 3,\ -7;\quad U = \dfrac{1}{5\sqrt{2}} \begin{pmatrix} 5 & -3-4i \\ 3-4i & 5 \end{pmatrix}$

11.47 $U = \dfrac{1}{2} \begin{pmatrix} -1 & i\sqrt{2} & 1 \\ -1 & -i\sqrt{2} & 1 \\ \sqrt{2} & 0 & \sqrt{2} \end{pmatrix}$

11.51 Reflection through the plane $3x - 2y - 3z = 0$, no rotation

11.52 $60°$ rotation about $-\mathbf{i}\sqrt{2} + \mathbf{k}$ and reflection through the plane $z = x\sqrt{2}$

11.53 $180°$ rotation about $\mathbf{i} + \mathbf{j} + \mathbf{k}$

11.54 $-120°$ (or $240°$) rotation about $\mathbf{i}\sqrt{2} + \mathbf{j}$

11.55 Rotation $-90°$ about $\mathbf{i} - 2\mathbf{j} + 2\mathbf{k}$, and reflection through the plane $x - 2y + 2z = 0$

11.56 $45°$ rotation about $\mathbf{j} - \mathbf{k}$

11.58 $f(M) = \dfrac{1}{5} \begin{pmatrix} f(1) + 4f(6) & 2f(1) - 2f(6) \\ 2f(1) - 2f(6) & 4f(1) + f(6) \end{pmatrix}$

$M^4 = \dfrac{1}{5} \begin{pmatrix} 1 + 4 \cdot 6^4 & 2 - 2 \cdot 6^4 \\ 2 - 2 \cdot 6^4 & 4 + 6^4 \end{pmatrix}$ $\qquad M^{10} = \dfrac{1}{5} \begin{pmatrix} 1 + 4 \cdot 6^{10} & 2 - 2 \cdot 6^{10} \\ 2 - 2 \cdot 6^{10} & 4 + 6^{10} \end{pmatrix}$

$e^M = \dfrac{e}{5} \begin{pmatrix} 1 + 4e^5 & 2(1 - e^5) \\ 2(1 - e^5) & 4 + e^5 \end{pmatrix}$

11.59 $M^4 = 2^3 \begin{pmatrix} 1 + 2^4 & 1 - 2^4 \\ 1 - 2^4 & 1 + 2^4 \end{pmatrix}$ $\qquad M^{10} = 2^3 \begin{pmatrix} 1 + 2^{10} & 1 - 2^{10} \\ 1 - 2^{10} & 1 + 2^{10} \end{pmatrix}$,

$e^M = e^3 \begin{pmatrix} \cosh 1 & -\sinh 1 \\ -\sinh 1 & \cosh 1 \end{pmatrix}$

12.2 $3x'^2 - 2y'^2 = 24$

12.3 $10x'^2 = 35$

12.4 $5x'^2 - 5y'^2 = 8$

12.5 $x'^2 + 3y'^2 + 6z'^2 = 14$

12.6 $3x'^2 + \sqrt{3}y'^2 - \sqrt{3}z'^2 = 12$

12.7 $3x'^2 + 5\,y'^2 - z'^2 = 60$

12.14 $y = x$ with $\omega = \sqrt{k/m}$; $y = -x$ with $\omega = \sqrt{5k/m}$

12.15 $y = 2x$ with $\omega = \sqrt{3k/m}$; $x = -2y$ with $\omega = \sqrt{8k/m}$

12.16 $y = 2x$ with $\omega = \sqrt{2k/m}$; $x = -2y$ with $\omega = \sqrt{7k/m}$

12.17 $x = -2y$ with $\omega = \sqrt{2k/m}$; $3x = 2y$ with $\omega = \sqrt{2k/(3m)}$

12.18 $y = x$ with $\omega = \sqrt{2k/m}$; $x = -5y$ with $\omega = \sqrt{16k/(5m)}$

12.19 $y = -x$ with $\omega = \sqrt{3k/m}$; $y = 2x$ with $\omega = \sqrt{3k/(2m)}$

12.21 $y = 2x$ with $\omega = \sqrt{k/m}$; $x = -2y$ with $\omega = \sqrt{6k/m}$

12.22 $y = -x$ with $\omega = \sqrt{2k/m}$; $y = 3x$ with $\omega = \sqrt{2k/(3m)}$

12.23 $y = -x$ with $\omega = \sqrt{k/m}$; $y = 2x$ with $\omega = \sqrt{k/(4m)}$

13.5 The 4's group 13.6 The cyclic group 13.7 The 4's group

13.10 If R = 90° rotation, P = reflection through the y axis, and Q = PR, then the 8 matrices of the symmetry group of the square are:

$\mathrm{I} = \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}$, $\mathrm{R} = \begin{pmatrix} 0 & -1 \\ 1 & 0 \end{pmatrix}$, $\mathrm{R}^2 = \begin{pmatrix} -1 & 0 \\ 0 & -1 \end{pmatrix} = -\mathrm{I}$,

$\mathrm{R}^3 = \begin{pmatrix} 0 & 1 \\ -1 & 0 \end{pmatrix} = -\mathrm{R}$, $\mathrm{P} = \begin{pmatrix} -1 & 0 \\ 0 & 1 \end{pmatrix}$, $\mathrm{PR} = \begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix} = \mathrm{Q}$,

$\mathrm{PR}^2 = \begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix} = -\mathrm{P}$, $\mathrm{PR}^3 = \begin{pmatrix} 0 & -1 \\ -1 & 0 \end{pmatrix} = -\mathrm{Q}$,

with multiplication table:

	I	R	−I	−R	P	Q	−P	−Q
I	I	R	−I	−R	P	Q	−P	−Q
R	R	−I	−R	I	−Q	P	Q	−P
−I	−I	−R	I	R	−P	−Q	P	Q
−R	−R	I	R	−I	Q	−P	−Q	P
P	P	Q	−P	−Q	I	R	−I	−R
Q	Q	−P	−Q	P	−R	I	R	−I
−P	−P	−Q	P	Q	−I	−R	I	R
−Q	−Q	P	Q	−P	R	−I	−R	I

13.11 The 4 matrices of the symmetry group of the rectangle are

$\mathrm{I} = \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}$, $\mathrm{P} = \begin{pmatrix} -1 & 0 \\ 0 & 1 \end{pmatrix}$, $\begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix} = -\mathrm{P}$, $\begin{pmatrix} -1 & 0 \\ 0 & -1 \end{pmatrix} = -\mathrm{I}$

This group is isomorphic to the 4's group.

13.14

Class	I	±R	−I	±P	±Q
Character	2	0	−2	0	0

13.20 Not a group (no unit element)

13.21 SO(2) is Abelian; SO(3) is not Abelian.

For Problems 2 to 10, we list a possible basis.

14.2 e^x, $x\,e^x$, e^{-x}, or the three given functions

14.3 x, $\cos x$, $x\cos x$, $e^x\cos x$

14.4 1, x, x^3

14.5 1, $x + x^3$, x^2, x^4, x^5

14.6 Not a vector space

14.7 $(1 + x^2 + x^4 + x^6)$, $(x + x^3 + x^5 + x^7)$

14.8 1, x^2, x^4, x^6

14.9 Not a vector space; the negative of a vector with positive coefficients does not have positive coefficients.

14.10 $(1 + \frac{1}{2}x)$, $(x^2 + \frac{1}{2}x^3)$, $(x^4 + \frac{1}{2}x^5)$, $(x^6 + \frac{1}{2}x^7)$, $(x^8 + \frac{1}{2}x^9)$, $(x^{10} + \frac{1}{2}x^{11})$, $(x^{12} + \frac{1}{2}x^{13})$

15.3 (a) $\frac{x-4}{1} = \frac{y+1}{-2} = \frac{z-2}{-2}$, $\mathbf{r} = (4, -1, 2) + (1, -2, -2)t$
(b) $x - 5y + 3z = 0$ (c) $5/7$
(d) $5\sqrt{2}/3$ (e) $\arcsin(19/21) = 64.8°$

15.4 (a) $4x + 2y + 5z = 10$ (b) $\arcsin(2/3) = 41.8°$
(c) $2/\sqrt{5}$ (d) $2x + y - 2z = 5$
(e) $x = \frac{5}{2}$, $\frac{y}{2} = z$, $\mathbf{r} = \frac{5}{2}\mathbf{i} + (2\mathbf{j} + \mathbf{k})t$

15.5 (a) $y = 7$, $\frac{x-2}{3} = \frac{z+1}{4}$, $\mathbf{r} = (2, 7, -1) + (3, 0, 4)t$
(b) $x - 4y - 9z = 0$ (c) $\arcsin\frac{33}{35\sqrt{2}} = 41.8°$
(d) $\frac{12}{7\sqrt{2}}$ (e) $\frac{\sqrt{29}}{5}$

15.7 $A^T = \begin{pmatrix} 1 & 0 \\ -1 & i \end{pmatrix}$ $\quad A^{-1} = \begin{pmatrix} 1 & -i \\ 0 & -i \end{pmatrix}$ $\quad AB = \begin{pmatrix} 2 & -2 & -6 \\ 0 & 3i & 5i \end{pmatrix}$

$\overline{A} = \begin{pmatrix} 1 & -1 \\ 0 & -i \end{pmatrix}$ $\quad B^T A^T = (AB)^T$ $\quad B^T AC = \begin{pmatrix} 2 & 2 \\ 1-3i & 1 \\ -1-5i & -1 \end{pmatrix}$

$A^\dagger = \begin{pmatrix} 1 & 0 \\ -1 & -i \end{pmatrix}$ $\quad B^T C = \begin{pmatrix} 0 & 2 \\ -3 & 1 \\ -5 & -1 \end{pmatrix}$ $\quad C^{-1}A = \begin{pmatrix} 0 & -i \\ 1 & -1 \end{pmatrix}$

$A^T B^T$, BA^T, ABC, $AB^T C$, $B^{-1}C$, and CB^T are meaningless.

15.8 $A^\dagger = \begin{pmatrix} 1 & -i & 1 \\ 0 & -3 & 0 \\ -2i & 0 & -i \end{pmatrix}$ $\quad A^{-1} = \dfrac{1}{3i}\begin{pmatrix} -3i & 0 & 6i \\ 1 & -i & -2 \\ 3 & 0 & -3 \end{pmatrix}$

15.9 $A = \begin{pmatrix} 1 + \frac{(n-1)d}{nR_2} & -(n-1)\left[\frac{1}{R_1} - \frac{1}{R_2} + \frac{(n-1)d}{nR_1R_2}\right] \\ \frac{d}{n} & 1 - \frac{(n-1)d}{nR_1} \end{pmatrix}$, $\quad \dfrac{1}{f} = -A_{12}$

15.10 $M = \begin{pmatrix} 1 - \frac{d}{f_2} & -\frac{1}{f_1} - \frac{1}{f_2} + \frac{d}{f_1 f_2} \\ d & 1 - \frac{d}{f_1} \end{pmatrix}$, $\quad \dfrac{1}{f} = \frac{f_1+f_2-d}{f_1 f_2}$, $\quad \det M = 1$

15.13 Area $= \frac{1}{2}\left|\overrightarrow{PQ} \times \overrightarrow{PR}\right| = 7/2$

15.14 $x'' = -x$, $y'' = -y$, 180° rotation

15.15 $x'' = -y$, $y'' = x$, 90° rotation of vectors or -90° rotation of axes

15.16 $x'' = y$, $y'' = -x$, $z'' = z$, 90° rotation of (x, y) axes about the z axis, or -90° rotation of vectors about the z axis

15.17 $x'' = x$, $y'' = -y$, $z'' = -z$, rotation of π about the x axis

15.18	1	$(1,1)$	15.19	6	$(1,1)$	15.20	1	$(1,1)$
	-2	$(0,1)$		1	$(1,-4)$		9	$(1,-1)$
15.21	0	$(1,-2)$	15.22	1	$(1,0,1)$	15.23	1	$(1,1,-2)$
	5	$(2,1)$		4	$(0,1,0)$		3	$(1,-1,0)$
				5	$(1,0,-1)$		4	$(1,1,1)$
15.24	2	$(0,4,3)$						
	7	$(5,-3,4)$						
	-3	$(5,3,-4)$						

15.25 $C = \dfrac{1}{\sqrt{2}}\begin{pmatrix} 1 & 0 \\ 1 & \sqrt{2} \end{pmatrix}$, $\quad C^{-1} = \begin{pmatrix} \sqrt{2} & 0 \\ -1 & 1 \end{pmatrix}$

15.26 $C = \begin{pmatrix} 1/\sqrt{2} & 1/\sqrt{17} \\ 1/\sqrt{2} & -4/\sqrt{17} \end{pmatrix}$, $\quad C^{-1} = \dfrac{1}{5}\begin{pmatrix} 4\sqrt{2} & \sqrt{2} \\ \sqrt{17} & -\sqrt{17} \end{pmatrix}$

15.27 $3x'^2 - y'^2 - 5z'^2 = 15$, $d = \sqrt{5}$

15.28 $9x'^2 + 4y'^2 - z'^2 = 36$, $d = 2$

15.29 $3x'^2 + 6y'^2 - 4z'^2 = 54$, $d = 3$

15.30 $7x'^2 + 20y'^2 - 6z'^2 = 20$, $d = 1$

15.31 $\omega = (k/m)^{1/2}$, $\quad (7k/m)^{1/2}$

15.32 $\omega = 2(k/m)^{1/2}$, $\quad (3k/m)^{1/2}$

Chapter 4

1.1	$\partial u/\partial x = 2xy^2/(x^2+y^2)^2$, $\partial u/\partial y = -2x^2y/(x^2+y^2)^2$				
1.2	$\partial s/\partial t = ut^{u-1}$, $\partial s/\partial u = t^u \ln t$				
1.3	$\partial z/\partial u = u/(u^2+v^2+w^2)$				
1.4	At $(0,\ 0)$, both $= 0$; at $(-2/3,\ 2/3)$, both $= -4$				
1.5	At $(0,\ 0)$, both $= 0$; at $(1/4,\ \pm 1/2)$, $\partial^2 w/\partial x^2 = 6$, $\partial^2 w/\partial y^2 = 2$				
1.7	$2x$	1.8	$-2x$	1.9	$2x(1+2\tan^2\theta)$
1.10	$4y$	1.11	$2y$	1.12	$2y(\cot^2\theta+2)$
1.13	$4r^2\tan\theta$	1.14	$-2r^2\cot\theta$	1.15	$r^2\sin 2\theta$
1.16	$2r(1+\sin^2\theta)$	1.17	$4r$	1.18	$2r$
1.19	0	1.20	$8y\sec^2\theta$	1.21	$-4x\csc^2\theta$
1.22	0	1.23	$2r\sin 2\theta$	1.24	0
1.7′	$-2y^4/x^3$	1.8′	$-2r^4/x^3$	1.9′	$2x\tan^2\theta\sec^2\theta$
1.10′	$2y+4y^3/x^2$	1.11′	$2yr^4/(r^2-y^2)^2$	1.12′	$2y\sec^2\theta$
1.13′	$2x^2\sec^2\theta\tan\theta(\sec^2\theta+\tan^2\theta)$				
1.14′	$2y^2\sec^2\theta\tan\theta$	1.15′	$2r^2\tan\theta\sec^2\theta$	1.16′	$2r\tan^2\theta$
1.17′	$4r^3/x^2-2r$	1.18′	$-2ry^4/(r^2-y^2)^2$		
1.19′	$-8r^3y^3/(r^2-y^2)^3$	1.20′	$4x\tan\theta\sec^2\theta(\tan^2\theta+\sec^2\theta)$		
1.21′	$4y\sec^2\theta\tan\theta$	1.22′	$-8r^3/x^3$		
1.23′	$4r\tan\theta\sec^2\theta$	1.24′	$-8y^3/x^3$		

2.1 $\quad y + y^3/6 - x^2y/2 + x^4y/24 - x^2y^3/12 + y^5/120 + \cdots$

2.2 $\quad 1 - (x^2+2xy+y^2)/2 + (x^4+4x^3y+6x^2y^2+4xy^3+y^4)/24 + \cdots$

2.3 $\quad x - x^2/2 - xy + x^3/3 + x^2y/2 + xy^2 \cdots$

2.4 $\quad 1 + xy + x^2y^2/2 + x^3y^3/3! + x^4y^4/4! \cdots$

2.5 $\quad 1 + \frac{1}{2}xy - \frac{1}{8}x^2y^2 + \frac{1}{16}x^3y^3 - \frac{5}{128}x^4y^4 \cdots$

2.6 $\quad 1 + x + y + (x^2+2xy+y^2)/2 \cdots$

2.8 $\quad e^x\cos y = 1 + x + (x^2-y^2)/2 + (x^3-3xy^2)/3! \cdots$

$\quad e^x\sin y = y + xy + (3x^2y-y^3)/3! \cdots$

4.2	2.5×10^{-13}	4.3	14.8	4.4	12.2	4.5	14.96
4.6	9%	4.7	15%	4.8	5%	4.10	4.28 nt
4.11	3.95	4.12	2.01	4.13	5/3	4.14	0.005
4.15	8×10^{23}						

5.1	$e^{-y}\sinh t + z\sin t$	5.2	$w = 1$, $dw/dp = 0$
5.3	$2r(q^2-p^2)$	5.4	$(4ut+2v\sin t)/(u^2-v^2)$
5.6	$5(x+y)^4(1+10\cos 10x)$	5.7	$(1-2b-e^{2a})\cos(a-b)$

6.1 $\quad dv/dp = -v/(ap)$, $\ d^2v/dp^2 = v(1+a)/(a^2p^2)$

6.2 $\quad y' = 1$, $y'' = 0$ $\qquad$ 6.3 $\quad y' = 4(\ln 2 - 1)/(2\ln 2 - 1)$

6.4 $y' = y(x-1)/[x(y-1)]$, $y'' = (y-x)(y+x-2)y/[x^2(y-1)^3]$

6.5 $2x + 11y - 24 = 0$

6.6 $1800/11^3$

6.7 $y' = 1$, $x - y - 4 = 0$

6.8 $-8/3$

6.9 $y = x - 4\sqrt{2}$, $y = 0$, $x = 0$

6.10 $x + y = 0$

6.11 $y'' = 4$

7.1 $dx/dy = z - y + \tan(y+z)$, $d^2x/dy^2 = \frac{1}{2}\sec^3(y+z) + \frac{1}{2}\sec(y+z) - 2$

7.2 $[2e^r \cos t - r + r^2 \sin^2 t]/[(1-r)\sin t]$

7.3 $\partial z/\partial s = z \sin s$, $\partial z/\partial t = e^{-y} \sinh t$

7.4 $\partial w/\partial u = -2(rv + s)w$, $\partial w/\partial v = -2(ru + 2s)w$

7.5 $\partial u/\partial s = (2y^2 - 3x^2 + xyt)u/(xy)$, $\partial u/\partial t = (2y^2 - 3x^2 + xys)u/(xy)$

7.6 $\partial^2 w/\partial r^2 = f_{xx}\cos^2\theta + 2f_{xy}\sin\theta\cos\theta + f_{yy}\sin^2\theta$

7.7 $(\partial y/\partial\theta)_r = x$, $(\partial y/\partial\theta)_x = r^2/x$, $(\partial\theta/\partial y)_x = x/r^2$

7.8 $\partial x/\partial s = -19/13$, $\partial x/\partial t = -21/13$, $\partial y/\partial s = 24/13$, $\partial y/\partial t = 6/13$

7.10 $\partial x/\partial s = 1/6$, $\partial x/\partial t = 13/6$, $\partial y/\partial s = 7/6$, $\partial y/\partial t = -11/6$

7.11 $\partial z/\partial s = 481/93$, $\partial z/\partial t = 125/93$

7.12 $\partial w/\partial s = w/(3w^3 - xy)$, $\partial w/\partial t = (3w-1)/(3w^3 - xy)$

7.13 $(\partial p/\partial q)_m = -p/q$, $(\partial p/\partial q)_a = 1/(a\cos p - 1)$,
$(\partial p/\partial q)_b = 1 - b\sin q$, $(\partial b/\partial a)_p = (\sin p)(b\sin q - 1)/\cos q$
$(\partial a/\partial q)_m = [q + p(a\cos p - 1)]/(q\sin p)$

7.14 13

7.15 $(\partial x/\partial u)_v = (2yv^2 - x^2)/(2yv + 2xu)$,
$(\partial x/\partial u)_y = (x^2u + y^2v)/(y^2 - 2xu^2)$

7.16 (a) $\dfrac{dw}{dt} = \dfrac{3(2x+y)}{3x^2+1} + \dfrac{4x}{4y^3+1} + \dfrac{10z}{5z^4+1}$

(b) $\dfrac{dw}{dx} = 2x + y - \dfrac{xy}{3y^2+x} + \dfrac{2z^2}{3z^2-x}$

(c) $\left(\dfrac{\partial w}{\partial x}\right)_y = 2x + y - \dfrac{2z(y^3+3x^2z)}{x^3+3yz^2}$

7.17 $(\partial p/\partial s)_t = -9/7$, $(\partial p/\partial s)_q = 3/2$

7.18 $(\partial b/\partial m)_n = a/(a-b)$, $(\partial m/\partial b)_a = 1$

7.19 $(\partial x/\partial z)_s = 7/2$, $(\partial x/\partial z)_r = 4$, $(\partial x/\partial z)_y = 3$

7.20 $(\partial u)/(\partial x)_y = 4/3$, $(\partial u/\partial x)_v = 14/5$, $(\partial x/\partial u)_y = 3/4$, $(\partial x/\partial u)_v = 5/14$

7.21 -1, -15, 2, $15/7$, $-5/2$, $-6/5$

7.26 $dy/dx = -(f_1g_3 - f_3g_1)/(f_2g_3 - g_2f_3)$

8.3 $(-1,\ 2)$ is a minimum point.

8.4 $(-1,\ -2)$ is a saddle point.

8.5 $(0,\ 1)$ is a maximum point.

8.6 $(0,\ 0)$ is a saddle point.
$(-2/3,\ 2/3)$ is a maximum point.

8.8 $\theta = \pi/3$; bend up 8 cm on each side.

8.9 $l = w = 2h$

8.10 $l = w = 2h/3$

8.11 $\theta = 30^\circ$, $x = y\sqrt{3} = z/2$

8.12 $d = 3$

8.13 $(4/3,\ 5/3)$

8.15 $(1/2,\ 1/2,\ 0)$, $(1/3,\ 1/3,\ 1/3)$

8.16 $m = 5/2$, $b = 1/3$

8.17 (a) $y = 5 - 4x$ (b) $y = 0.5 + 3.35x$ (c) $y = -3 - 3.6x$

9.1 $s = l$, $\theta = 30^\circ$ (regular hexagon)

9.2 $r : l : s = \sqrt{5} : (1+\sqrt{5}) : 3$

9.3 36 in by 18 in by 18 in

9.4 $4/\sqrt{3}$ by $6/\sqrt{3}$ by $10/\sqrt{3}$

9.5 $(1/2,\ 3,\ 1)$

9.6 $V = 1/3$

9.7 $V = d^3/(27abc)$

9.8 $(8/13,\ 12/13)$

9.9 $A = 3ab\sqrt{3}/4$

9.10 $d = 5/\sqrt{2}$

9.11 $d = \sqrt{6}/2$

9.12 Let legs of right triangle be a and b, height of prism $= h$; then $a = b$, $h = \left(2 - \sqrt{2}\right) a$.

10.1 $d = 1$

10.2 4, 2

10.3 2, $\sqrt{14}$

10.4 $d = 1$

10.5 $d = 1$

10.6 $d = 2$

10.7 $\frac{1}{2}\sqrt{11}$

10.8 $T = 8$

10.9 $\max T = 4$ at $(-1,\ 0)$
$\min T = -\frac{16}{5}$ at $\left(\frac{1}{5}, \pm\frac{2}{5}\sqrt{6}\right)$

10.10 (a) $\max T = 1/2$, $\min T = -1/2$
(b) $\max T = 1$, $\min T = -1/2$
(c) $\max T = 1$, $\min T = -1/2$

10.11 $\max T = 14$ at $(-1,\ 0)$
$\min T = 13/2$ at $(1/2,\ \pm 1)$

10.12 Largest sum $= 180°$
Smallest sum $= 3 \operatorname{arc\,cos} \frac{1}{\sqrt{3}}$
$= 164.2°$

10.13 Largest sum $= 3 \operatorname{arc\,sin}(1/\sqrt{3}) = 105.8°$, smallest sum $= 90°$

11.1 $z = f(y + 2x) + g(y + 3x)$

11.2 $z = f(5x - 2y) + g(2x + y)$

11.3 $w = (x^2 - y^2)/4 + F(x + y) + G(x - y)$

11.6 $\dfrac{d^2y}{dz^2} + \dfrac{dy}{dz} - 5y = 0$

11.10 $f = u - Ts$ $\quad h = u + pv$ $\quad g = u + pv - Ts$
$df = -p\ dv - s dT$ $\quad dh = T ds + v dp$ $\quad dg = v\ dp - s\ dT$

11.11 $H = p\dot{q} - L$

11.13 (a) $(\partial s/\partial v)_T = (\partial p/\partial T)_v$ (b) $(\partial T/\partial p)_s = (\partial v/\partial s)_p$
(c) $(\partial v/\partial T)_p = -(\partial s/\partial p)_T$

12.1 $\dfrac{\sin x}{2\sqrt{x}}$

12.2 $\dfrac{\partial s}{\partial v} = \dfrac{1 - e^v}{v} \to -1$; $\dfrac{\partial s}{\partial u} = \dfrac{e^u - 1}{u} \to 1$

12.3 $dz/dx = -\sin(\cos x)\tan x - \sin(\sin x)\cot x$

12.4 $(\sin 2)/2$

12.5 $\partial u/\partial x = -4/\pi,\ \ \partial u/\partial y = 2/\pi,\ \ \partial y/\partial x = 2$

12.6 $\partial w/\partial x = 1/\ln 3,\ \ \partial w/\partial y = -6/\ln 3,\ \ \partial y/\partial x = 1/6$

12.7 $(\partial u/\partial x)_y = -e^4,\ \ (\partial u/\partial y)_x = e^4/\ln 2,\ \ (\partial y/\partial x)_u = \ln 2$

12.8 $dx/du = e^{x^2}$

12.9 $(\cos \pi x + \pi x \sin \pi x - 1)/x^2$

12.10 $dy/dx = (e^x - 1)/x$

12.11 $3x^2 - 2x^3 + 3x - 6$

12.12 $(2x + 1)/\ln(x + x^2) - 2/\ln(2x)$

12.13 0

12.14 $\pi/(4y^3)$

12.16 $n = 2$, $I = \frac{1}{4}\sqrt{\pi}\, a^{-3/2}$ $\quad n = 4$, $I = \dfrac{1 \cdot 3}{8}\sqrt{\pi}\, a^{-5/2}$
$n = 2m$, $I = \dfrac{1 \cdot 3 \cdot 5\ \cdots\ (2m - 1)}{2^{m+1}}\sqrt{\pi}\, a^{-(2m+1)/2}$

13.2 (a) and (b) $d = 4/\sqrt{13}$

13.3 $\sec^2\theta$

13.4 $-\csc\theta\cot\theta$

13.5 $-6x$, $2x^2\tan\theta\sec^2\theta$, $4x\tan\theta\sec^2\theta$

13.6 $2r\sin^2\theta$, $2r^2\sin\theta\cos\theta$, $4r\sin\theta\cos\theta$, 0

13.7 5%

13.8 π^{-1}ft $\cong$ 4 inches
13.9 $dz/dt = 1 + t(2 - x - y)/z,\ z \neq 0$
13.10 $(x \ln x - y^2/x)x^y$ where $x = r\cos\theta,\ y = r\sin\theta$
13.11 $\dfrac{dy}{dx} = -\dfrac{b^2x}{a^2y},\ \ \dfrac{d^2y}{dx^2} = -\dfrac{b^4}{a^2y^3}$
13.12 13
13.13 -1
13.14 $(\partial w/\partial x)_y = (\partial f/\partial x)_{s,\ t} + 2(\partial f/\partial s)_{x,\ t} + 2(\partial f/\partial t)_{x,\ s} = f_1 + 2f_2 + 2f_3$
13.15 $(\partial w/\partial x)_y = f_1 + 2xf_2 + 2yf_3$
13.17 $\sqrt{19}$
13.18 $\sqrt{26/3}$
13.19 $1/27$
13.20 At $x = -1$, $y = 20$; at $x = 1/2$, $y = -1/4$
13.21 $T(2) = 4$, $T(5) = -5$
13.22 $T(5,\ 0) = 10$, $T(2,\ \pm\sqrt{2}) = -4$
13.23 $t \cot t$
13.24 0
13.25 $-e^x/x$
13.26 $3\sin x^3/x$
13.29 $dt = 3.9$
13.30 $2f(x,\ x) + \int_0^x \frac{\partial}{\partial x}\left[f(x,\ u) + f(u,\ x)\right] du$

Chapter 5

2.1	3	2.2	-18	2.3	4	2.4	$8/3$
2.5	$\dfrac{e^2}{4} - \dfrac{5}{12}$	2.6	2.35	2.7	$5/3$	2.8	$1/2$
2.9	6	2.10	5π	2.11	36	2.12	2
2.13	$7/4$	2.14	$4 - e(\ln 4)$	2.15	$3/2$	2.16	$(\ln 3)/6$
2.17	$(\ln 2)/2$	2.18	$(8\sqrt{2} - 7)/3$	2.19	32	2.20	16
2.21	$131/6$	2.22	$5/3$	2.23	$9/8$	2.24	$9/2$
2.25	$3/2$	2.26	$4/3$	2.27	$32/5$	2.28	$1/3$
2.29	2	2.30	$1 - e^{-2}$	2.31	6	2.32	$e - 1$
2.33	$16/3$	2.34	$8192k/15$	2.35	$216k$	2.36	$1/6$
2.37	$7/6$	2.38	-20	2.39	70	2.40	$3/2$
2.41	5	2.42	4	2.43	$9/2$	2.44	$7k/3$
2.45	$46k/15$	2.46	$8k$	2.47	$16/3$	2.48	$16\pi/3$
2.49	$1/3$	2.50	$64/3$				

3.2 (a) ρl (b) $Ml^2/12$ (c) $Ml^2/3$

3.3 (a) $M = 140$ (b) $\bar{x} = 130/21$ (c) $I_m = 6.92M$ (d) $I = 150M/7$

3.4 (a) $M = 3l/2$ (b) $\bar{x} = 4l/9$ (c) $I_m = \frac{13}{162}Ml^2$ (d) $I = 5Ml^2/18$

3.5 (a) $Ma^2/3$ (b) $Ma^2/12$ (c) $2Ma^2/3$

3.6 (a) $(2, 2)$ (b) $6M$ (c) $2M$

3.7 (a) $M = 9$ (b) $(\bar{x}, \bar{y}) = (2, 4/3)$
(c) $I_x = 2M$, $I_y = 9M/2$ (d) $I_m = 13M/18$

3.8 $2Ma^2/3$

3.9 (a) $1/6$ (b) $(1/4, 1/4, 1/4)$ (c) $M = 1/24$, $\bar{z} = 2/5$

3.10 (a) $s = 2\sinh 1$ (b) $\bar{y} = (2 + \sinh 2)/(4\sinh 1) = 1.2$

3.11 (a) $M = (5\sqrt{5} - 1)/6 = 1.7$
(b) $\bar{x} = 0$, $M\bar{y} = (25\sqrt{5} + 1)/60 = 0.95$, $\bar{y} = (313 + 15\sqrt{5})/620 = 0.56$

3.14 $V = 2\pi^2 a^2 b$, $A = 4\pi^2 ab$, where $a =$ radius of revolving circle,
$b =$ distance to axis from center of this circle.

3.15 For area, $(\bar{x}, \bar{y}) = (0, \frac{4}{3}r/\pi)$; for arc, $(\bar{x}, \bar{y}) = (0, 2r/\pi)$

3.17 $4\sqrt{2}/3$ 3.18 $s = \left[3\sqrt{2} + \ln(1 + \sqrt{2})\right]/2 = 2.56$

3.19 2π 3.20 $13\pi/3$

3.21 $s\bar{x} = \left[51\sqrt{2} - \ln(1 + \sqrt{2})\right]/32 = 2.23$, $s\bar{y} = 13/6$, s as in Problem 3.18;
then $\bar{x} = 0.87$, $\bar{y} = 0.85$

3.22 $(4/3, 0, 0)$

3.23 $(149/130, 0, 0)$

3.24 $2M/5$

3.25 I/M has the same numerical value as $\bar{x}$ in 3.21.

3.26 $2M/3$ 3.27 $\frac{149}{130}M$ 3.28 $13/6$ 3.29 2 3.30 $32/5$

4.1 (b) $\bar{x} = \bar{y} = 4a/(3\pi)$
(c) $I = Ma^2/4$
(e) $\bar{x} = \bar{y} = 2a/\pi$
4.2 (c) $\bar{y} = 4a/(3\pi)$
(d) $I_x = Ma^2/4$, $I_y = 5Ma^2/4$, $I_z = 3Ma^2/2$
(e) $\bar{y} = 2a/\pi$
(f) $\bar{x} = 6a/5$, $I_x = 48Ma^2/175$, $I_y = 288Ma^2/175$, $I_z = 48Ma^2/25$
(g) $A = (\frac{2}{3}\pi - \frac{1}{2}\sqrt{3})a^2$
4.3 (a), (b), or (c) $\frac{1}{2}Ma^2$
4.4 (a) $4\pi a^2$ (b) $(0, 0, a/2)$ (c) $2Ma^2/3$
(d) $4\pi a^3/3$ (e) $(0, 0, 3a/8)$
4.5 $7\pi/3$ 4.6 $\pi \ln 2$
4.7 (a) $V = 2\pi a^3(1 - \cos\alpha)/3$ (b) $\bar{z} = 3a(1 + \cos\alpha)/8$
4.8 $I_z = Ma^2/4$
4.10 (a) $V = 64\pi$ (b) $\bar{z} = 231/64$
4.11 12π
4.12 (c) $M = (16\rho/9)(3\pi - 4) = 9.64\rho$
$I = (128\rho/15^2)(15\pi - 26) = 12.02\rho = 1.25M$
4.13 (b) $\pi a^2(z_2 - z_1) - \pi(z_2^3 - z_1^3)/3$ (c) $\dfrac{\frac{1}{2}a^2(z_2^2 - z_1^2) - \frac{1}{4}(z_2^4 - z_1^4)}{a^2(z_2 - z_1) - (z_2^3 - z_1^3)/3}$
4.14 $\pi(1 - e^{-1})/4$ 4.16 $u^2 + v^2$
4.17 $a^2(\sinh^2 u + \sin^2 v)$ 4.19 $\pi/4$
4.20 $1/12$ 4.22 $12(1 + 36\pi^2)^{1/2}$
4.23 Length $= (R \sec\alpha)$ times change in latitude
4.24 $\rho G\pi a/2$
4.26 (a) $7Ma^2/5$ (b) $3Ma^2/2$
4.27 $2\pi ah$ (where $h =$ distance between parallel planes)
4.28 $(0, 0, a/2)$

5.1 $9\pi\sqrt{30}/5$ 5.2 $\pi\sqrt{7/5}$
5.3 $\pi(37^{3/2} - 1)/6 = 117.3$ 5.4 $\pi/\sqrt{6}$
5.5 8π for each nappe 5.6 4
5.7 4 5.8 $\left[3\sqrt{6} + 9\ln(\sqrt{2} + \sqrt{3}\,)\right]/16$
5.9 $\pi\sqrt{2}$ 5.10 $2\pi a^2(\sqrt{2} - 1)$
5.11 $(\bar{x}, \bar{y}, \bar{z}) = (1/3, 1/3, 1/3)$ 5.12 $M = \sqrt{3}/6$, $(\bar{x}, \bar{y}, \bar{z}) = (1/2, 1/4, 1/4)$
5.13 $\bar{z} = \dfrac{\pi}{4(\pi - 2)}$ 5.14 $M = \dfrac{\pi}{2} - \dfrac{4}{3}$
5.15 $I_z/M = \dfrac{2(3\pi - 7)}{9(\pi - 2)} = 0.472$ 5.16 $\bar{x} = 0$, $\bar{y} = 1$, $\bar{z} = \dfrac{32}{9\pi}\sqrt{\dfrac{2}{5}} = 0.716$

6.1 $7\pi(2 - \sqrt{2})/3$ 6.2 $45(2 + \sqrt{2})/112$ 6.3 $15\pi/8$
6.4 (a) $\frac{1}{2}MR^2$ (b) $\frac{3}{2}MR^2$
6.5 cone: $2\pi ab^2/3$; ellipsoid: $4\pi ab^2/3$; cylinder: $2\pi ab^2$
6.6 (a) $\dfrac{4\pi - 3\sqrt{3}}{6}$ (b) $\bar{x} = \dfrac{5}{4\pi - 3\sqrt{3}}$, $\bar{y} = \dfrac{6\sqrt{3}}{4\pi - 3\sqrt{3}}$
6.7 $\dfrac{8\pi - 3\sqrt{3}}{4\pi - 3\sqrt{3}}M$ 6.8 (a) $5\pi/3$ (b) $27/20$
6.9 $(\bar{x}, \bar{y}) = (0, 3c/5)$
6.10 (a) $(\bar{x}, \bar{y}) = (\pi/2, \pi/8)$ (b) $\pi^2/2$ (c) $3M/8$
6.11 $\bar{z} = 3h/4$ 6.12 $(abc)^2/6$
6.13 $8a^2$ 6.14 $16a^3/3$
6.15 $I_x = 8Ma^2/15$, $I_y = 7Ma^2/15$ 6.16 $\bar{x} = \bar{y} = 2a/5$

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