Section 5.1

1a) zeros are $x = 3$ multiplicity even    $x = -1$ multiplicity odd
1b) touches the x-axis at $x = 3$, crosses the x-axis at $x = -1$
1c) has at most 2 turning points
1d) sketch a graph and approximate the turning points, also label the x-intercepts

1e) falls to the left, rises to the right
1f) increasing $(-\infty, 0.33) \cup (3, \infty)$ decreasing $(0.33, 3)$

3a) zeros are $x = 3$ has odd multiplicity    and $x = -4$ odd multiplicity
3b) graph crosses x-axis at $x = 3$ and crosses x-axis at $x = -4$
3c) has at most 3 turning points
3d)

I rounded the y-coordinate of the min to an integer as the decimal was hard to read on my graph.

3e) rises to the left, rises to the right
3f) increasing $(-2.25, \infty)$    decreasing $(-\infty, -2.25)$
Section 5.1 continued

5a) \((-3, 0) (3,0) (-6,0)\) all have odd multiplicity

5b) graph crosses at each x-intercept \((-3, 0) (3,0) (-6,0)\)

5c) will have at most 2 turning points

5d)

The points were hard to read on the graph. I've just made dots on the graph to keep it clean.

The x-intercepts are \((-6,0) (-3,0)\) and \((3,0)\)

The maximum point is \((-4.65, 17.04)\)

The minimum point is \((.65, -57.04)\)

5e) Falls to the left rises to the right

5f) increasing \((-\infty, -4.65) \cup (.65, \infty)\) decreasing \((-4.65, .65)\)
Section 5.1 continued

7a) \((-3,0)\) has even multiplicity, \((2,0)\) has odd multiplicity
7b) Graph touches at \((-3,0)\) and crosses at \((2,0)\)
7c) has at most 2 turning points

7d)

7e) falls to the left and rises to the right

7f) increasing \((-\infty, -3) \cup (.33, \infty)\) decreasing \((-3, .33)\)
Section 5.1 continued

9a) \((-7,0)\) odd multiplicity, \((1,0)\) odd multiplicity
9b) graph crosses at both \((-7,0)\) and \((1,0)\)
9c) has at most 1 turning points
9d)

\[
\begin{array}{c}
\text{(-7,0)} \\
\text{(1,0)} \\
\text{(-3,10)}
\end{array}
\]

9e) rises to the left and rises to the right

9f) increasing \((-3, \infty)\) decreasing \((-\infty, -3)\)
Section 5.1 continued

11a) (-2,0) odd multiplicity, (2,0) odd multiplicity
11b) Graph crosses the x-axis at (-2,0) and (2,0)
11c) has at most 1 turning points
11d)

11e) rises to the left, rises to the right

11f) decreasing $(-\infty, 0)$ increasing $(0, \infty)$
Section 5.1 continued

13a) (0, 0), odd multiplicity  (1, 0) odd multiplicity  x = (5, 0) odd multiplicity
13b) graph crosses x-axis at each x-intercept
13c) has at most 2 turning points.
13d) it got hard to read the points when I showed them on the graph.

The maximum point is (.47, 1.13)
The minimum point is (3.53, -13.13)

13e) falls to left and rise to the right

13f) increases $(-\infty, .47) \cup (3.53, \infty)$ decreases (.47, 3.53)
Section 5.1 continued

15a) \((0,0)\) has even multiplicity, \((2,0)\) has odd multiplicity \((-2,0)\) has odd multiplicity
15b) graph touches at \((0,0)\) and crosses at \((-2,0)\) and crosses at \((2,0)\)
15c) has at most 3 turning points
15d) [diagram]
15e) falls to the left, falls to the right
15f) increasing \((-\infty, -1.41)\) \(\cup\) \((0, 1.41)\) decreasing \((-1.41, 0)\) \((1.41, \infty)\)

17) \(f(x) = x^2 + x - 12\)
19) \(f(x) = 2x^2 - 7x + 3\)
21) \(f(x) = 4x^3 - 3x^2 - 36x + 27\)
23) \(f(x) = x^2 - 2\)
25) \(f(x) = x^3 - 6x^2 - 2x + 12\)
Section 5.2
1a) \(3x^2 - 2x + 5\) remainder 0  
1b) \(3x^3 - 17x^2 + 15x - 25 = (x-5)(3x^2 - 2x + 5)\)
2a) \(4x^2 - 9\) remainder 0  
2b) \(4x^3 + 8x^2 - 9x - 18 = (x+2)(2x+3)(2x-3)\)
3a) \(3x^2 + 2x + 12\) remainder 0  
3b) \(3x^3 - 16x^2 - 72 = (x-6)(3x^2 + 2x + 12)\)
4a) \(5x^2 - 10x + 26\) remainder -44  
4b) not applicable, remainder is not 0
5a) \(3x^2 + 2x + 5\) remainder 0  
5b) \(3x^3 - 16x^2 - 72 = (x-6)(3x^2 + 2x + 12)\)
6a) \(x^2 + 3x + 9\) remainder 0  
6b) \((x-3)(x^2 + 3x + 9)\)
7a) \(4x^2 - 9\) remainder 0  
7b) \((x+2)(2x+3)(2x-3)\)
8a) \(4x^3 + 8x^2 - 9x - 18\) remainder 0  
8b) \((x-6)(3x^2 + 2x + 12)\)
9a) \(x^2 + 3x + 9\) remainder 0  
9b) \((x-3)(x^2 + 3x + 9)\)
10a) \((-1)\) is a zero, there are others  
10b) \(f(x) = (x+1)(x-2)(x+3)\)
11a) \((-1)\) is a zero, there are others  
11b) \(x = -1, 2, -3\)
12a) \(3\) is a zero  
12b) \(f(x) = (x-3)(x-3)(2x-1)\) or \((x-3)^2(2x-1)\)
13a) \((-2)\) and \((2)\) and \((5)\) are zeros  
13b) \(x = 2, -2, 5\)
14a) \((-5)\) and \((1)\) are zeros  
14b) \(f(x) = (x+5)(x-1)(2x+3)(x+3)\)
15a) \((-1)\) and \((1)\) are zeros  
15b) \(x = 1, -1, \pm 2\sqrt{2}i\)
16a) \((-1)\) and \((1)\) are zeros  
16b) \(f(x) = x^4 + 7x^2 - 8 = (x+1)(x-1)(x^2 + 8)\)
17a) \((-5)\) and \((1)\) are zeros  
17b) \(f(x) = (x+5)(x-1)(2x+3)(x+3)\)
18a) \((-1)\) and \((1)\) are zeros  
18b) \(x = 2i, -2i, 4\)
19a) \((-1)\) and \((1)\) are zeros  
19b) \(x = 1, -1, \pm 2\sqrt{2}i\)
20a) \((-1)\) and \((1)\) are zeros  
20b) \(f(x) = x^4 + 7x^2 - 8 = (x+1)(x-1)(x^2 + 8)\)
21a) \((-5)\) and \((1)\) are zeros  
21b) \(f(x) = (x+5)(x-1)(2x+3)(x+3)\)
22a) \((-1)\) and \((1)\) are zeros  
22b) \(x = 2i, -2i, 4\)

Section 5.3
1) \(f(x) = x^2 + 9\)  
3) \(f(x) = x^3 + 4x^2 + 25x + 100\)
5) \(f(x) = x^3 - 2x^2 + 9x - 18\)  
7) \(f(x) = x^4 + 40x^2 + 144\)
9) \(f(x) = x^2 - 6x + 10\)  
11) \(f(x) = x^2 - 10x + 26\)
13) \(x = 2i, -2i, 4\) you may write \(\pm 2i, 4\)
15) \(x = 3i, -3i, 4\) you may write \(\pm 3i, 4\)
Section 5.4

1a) domain all real numbers except (-3)  
1b) vertical asymptote equation x = -3

3a) domain all real numbers except -1 and 4  
3b) answer: vertical asymptote x = -1 and x = 4

5a) domain all real numbers except 2, -2  
5b) vertical asymptote x = 2 and x = -2

7a) domain all real numbers except 0 and 1  
7b) vertical asymptote x = 0 and x = 1

9a) domain all real numbers except 6  
9b) answer: vertical asymptote x = 6

11a) domain all real numbers except 3 and -3  
11b) vertical asymptote x = 3 and x = -3

13a) domain all real numbers  
13b) vertical asymptote none

15a) domain all real numbers  
15b) vertical asymptote none

17) x-intercept (3,0) y-intercept (0,{-2})

19) x-intercept (-4,0) y-intercept (0,{-3})

21) x-intercept (-2/3,0) (4,0) y-intercept (0,2)

Section 5.4 continues

23) x-intercept (-4,0) (4,0) y-intercept none

25) x-intercept none y-intercept (0,-1/2)

27) x-intercept (0,0) y-intercept (0,0)

29) x-intercept (-2,0) y-intercept (0,1/8)

31) x-intercept (0,0) y-intercept (0,0)

33) y = 2  
35) y = 0  
37) y = 3  
39) y = 1

41) y = 0  
43) y = 0  
45) y = 0  
47) y = 5

49) y = x + 2  
51) y = x + 9  
53) y = 3x + 4
1) a) domain: all real numbers except 6
   b) vertical asymptote \( x = 6 \)
   c) horizontal asymptote \( y = 3 \)
   d) x-intercept \((-2,0)\)
   e) y-intercept \((0,-1)\)

window used
\[ x\text{-min} = -30 \quad x\text{-max} = 30 \]
\[ y\text{-min} = -30 \quad y\text{-max} = 30 \]
Section 5.5

3) a) domain: all real numbers except 1, -1
   b) vertical asymptotes $x = 1 \; x = -1$
   c) horizontal asymptote $y = 4$
   d) $x$-intercept $(3/2, 0)$ $(3/2, 0)$
   e) $y$-intercept $(9,0)$
   window used:
   $x$-min -10 $x$-max 10 $y$-min -10 $y$-max 20

5) a) domain: all real numbers except 0
   b) vertical asymptote $x = 0$
   c) horizontal asymptote $y = 0$
   d) $x$-intercept none
   e) $y$-intercept none
   window used:
   $x$-min -5 $x$-max 5 $y$-min -5 $y$-max 5
Section 5.5

7)  
a) domain: all real numbers except 4, -4  
b) vertical asymptotes  x = 4   x = -4  
c) horizontal asymptote  y = 0  
d) x-intercept (-3,0)  
e) y-intercept (0, 3/16)  
window x-min -10  x-max 10  y-min -10  y-max 10

9)  
a) domain: all real numbers except -3  
b) vertical asymptote  x = -3  
c) horizontal asymptote  y = x+2  
d) x-intercept (-6,0) (1,0)  
e) y-intercept (0,-2)
Section 5.5

11) a) domain: all real numbers except 2
    b) vertical asymptote $x = 2$
    c) horizontal asymptote $y = x + 9$
    d) x-intercept (-5,0) (-2,0)
    e) y-intercept (0,-5)

window used $x$-min -10 $x$-max 10 $y$-min -80 $y$-max 80

13) a) domain: all real numbers except -3
    b) vertical asymptote $x = -3$
    c) horizontal asymptote $y = 3/2$
    d) x-intercept (4,0)
    e) y-intercept (0,-2)

window used $x$-min -20 $x$-max 20 $y$-min -20 $y$-max 20

Section 5.5
15) a) domain: all real numbers except 0
   b) vertical asymptote x = 0
   c) horizontal asymptote y = 0
   d) x-intercept none
   e) y-intercept none

   window: x-min -10 x-max 10
   y-min -10 y-max 10

17) a) domain: all real numbers except 0
   b) vertical asymptote x = 0
   c) horizontal asymptote y = 0
   d) x-intercept (-5,0)
   e) y-intercept none

   window used x-min -10 x-max 10 y-min -2 y-max 2
   this window shows what happens around the x-intercept well, but doesn’t show the vertical asymptote effect very well. I can’t find a window to show both.
Section 5.6

1a) \( f(x) > 0 \) \((-\infty, -4) \cup (3, \infty)\)

1b) \( f(x) < 0 \) \((-4,3)\)

3a) \( f(x) < 0 \) \((-4,3)\)

3b) \( f(x) > 0 \) \((-\infty, -4) \cup (3, \infty)\)

5a) \( f(x) > 0 \) \((-\infty, -4) \cup (3, 6)\)

5b) \( f(x) < 0 \) \((-4,3) \cup 6, \infty)\)

7a) \( f(x) > 0 \) \((-\infty, -2) \cup (3, \infty)\)

7b) \( f(x) < 0 \) \((-4,3)\)

9a) \( f(x) \geq 0 \) \([-5,3] \cup [7, \infty)\)

9b) \( f(x) \leq 0 \) \((-\infty, -5] \cup [3,7]\)

11a) \( f(x) \geq 0 \) \((-\infty, 2] \cup [2, \infty)\) okay to write \((-\infty, \infty)\)

11b) \( f(x) \leq 0 \) \{2\} The graph is never below the x-axis, but it does touch the x-axis when \(x=2\) and this should be noted in the answer to part b.

13a) \( f(x) \geq 0 \) \([-5,3] \cup [3,\infty)\) may also be written as \([-5, \infty)\)

13b) \( f(x) \leq 0 \) \((-\infty, -5] \cup \{3\}\) every x-intercept needs to be included in the answers to part a and b. The single number \(x = 3\) satisfies \(f(x) = 0\) and needs to part of the answer to 13b.

15a) \( f(x) \geq 0 \) \((-\infty, -5] \cup [4, \infty)\)

15b) \( f(x) \leq 0 \) \((-5,4]\)

17a) \( f(x) \geq 0 \) \((-6, -2] \cup [3, \infty)\)

17b) \( f(x) \leq 0 \) \((-\infty, -6) \cup (-2,3]\)

19a) \( f(x) \geq 0 \) \((0, \infty)\)

19b) \( f(x) \leq 0 \) \((-\infty, 0)\)

21a) \( f(x) > 0 \) \((-\infty, -6) \cup (1, \infty)\)

21b) \( f(x) < 0 \) \((-6,1)\)

23a) \( f(x) > 0 \) \((-3,3)\)

23b) \( f(x) < 0 \) \((-\infty, -3) \cup (3, \infty)\)

25a) \( f(x) > 0 \) \((-6,3) \cup (3, \infty)\)

25b) \( f(x) < 0 \) \((-\infty, -6) \cup (-3,3]\)

27a) \( f(x) > 0 \) \((-6,0) \cup (1, \infty)\)

27b) \( f(x) < 0 \) \((-\infty, -6) \cup (0,1)\)

29a) \( f(x) > 0 \) \((-\infty, -3) \cup (4, \infty)\)

29b) \( f(x) < 0 \) \((-3,4)\)

31a) \( f(x) > 0 \) \((-2,2) \cup (5, \infty)\)

31b) \( f(x) < 0 \) \((-\infty, -2) \cup (2,5)\)

33a) \( f(x) \geq 0 \) \((-\infty, 0] \cup [5, \infty)\)

33b) \( f(x) \leq 0 \) \([0,5]\)

35a) \( f(x) \geq 0 \) \((-\infty, 2] \cup [2, \infty)\) okay to write \((-\infty, \infty)\)

35b) \( f(x) \leq 0 \) \{2\} The graph is never below the x-axis, but it does touch the x-axis when \(x=2\) and this should be noted in the answer to part b.
Section 5.6

37a) \( f(x) \geq 0 \quad [-5,3] \cup [3,\infty) \) which can be reduced to \([-5,\infty)\)

37b) \( f(x) \leq 0 \quad (-\infty,-5] \cup \{3\} \)

need to include the point \( x = 3 \) along with the interval as the graph touches the x-axis at \( x=3 \).

39a) \( f(x) \geq 0 \quad (-\infty,-2] \cup (6,\infty) \)

39b) \( f(x) \leq 0 \quad [-2,6) \)

41a) \( f(x) \geq 0 \quad [-6 - 3) \cup (3,\infty) \)

41b) \( f(x) \leq 0 \quad (-\infty,-6] \cup (-3,3) \)
Chapter 5 review

1a) (5,0) even multiplicity, (3,0) odd multiplicity
1b) graph touches x-axis at (5,0) graph crosses x-axis at (3,0)
1c) at most 2 turning points
1d) sketch a graph and approximate the turning points, also label the x-intercepts
1e) falls to the left, rises to the right
1f) increasing \((-\infty, 3.67) \cup (5, \infty)\) decreasing (3.67, 5)

2a) (-5,0) odd mult (3,0) odd mult
2b) crosses at (-5,0) crosses at (3,0)
2c) will have at most 1 turning point.
2d) sketch a graph and approximate the turning points, also label the x-intercepts
2e) rise left and rises to the right
2f) increasing \((-1, \infty)\) decreasing \((-\infty, -1)\)
Chapter 5 review

3a) The x-intercepts are (0,0) (-4,0) and (2,0) each has odd multiplicity.
3b) graph will cross x-axis at all three x-intercepts
3c) at most 2 turning points.
3d) sketch a graph and approximate the turning points, also label the x-intercepts

3e) falls to the left, rises to the right
3f) increasing $(-\infty, -2.43) \cup (1.10, \infty)$ decreasing $(-2.43, 1.10)$

4a) I graphed and found the graph crossed the x-axis at x = 3. I will do my synthetic division with x =3, but you could also use -1 or -3
4b) $f(x) = (x-3)(x+3)(x+1)$
4c) $x = 3, -3, -1$
5a) $x = -2$
5b) $f(x) = (x + 2)(2x – 3)(2x + 3)$
5c) $x = -2, 2/3$ and $-2/3$
6) $f(x) = x^2 + x - 12$
7) $f(x) = x^3 + 5x^2 + 16x + 80$
Chapter 5 review

8a) all real numbers except 3  
8b) x = 3  
8c) y = 2  
8d) (-3,0)  
8e) (0,-2)  
8f)

9a) all real numbers except -5,2  
9b) vertical asymptotes x = -5 and x = 2  
9c) y = 0 (the x-axis)  
9d) (1,0)  
9e) (0, 1/10)  
9f)
Chapter 5 review

10a) \( f(x) \geq 0 \) \((-\infty, -4) \cup [3, \infty)\)
10b) \( f(x) \leq 0 \) \((-4, 3]\)
11a) \( f(x) > 0 \) \((-4, 3) \cup (6, \infty)\)
11b) \( f(x) < 0 \) \((-\infty, -4) \cup (3, 6)\)
12a) \( f(x) \geq 0 \) \((-\infty, -7] \cup [1, \infty)\)
12b) \( f(x) \leq 0 \) \([-7, 1]\)
13a) \( f(x) \geq 0 \) \((-\infty, -3] \cup (4, \infty)\)
13b) \( f(x) \leq 0 \) \([-3, 4]\)
14a) \( f(x) > 0 \) \((-9, 0) \cup (3, \infty)\)
14b) \( f(x) < 0 \) \((-\infty, -9) \cup (0, 3)\)
15a) \( f(x) > 0 \) \((-3, 1) \cup (3, \infty)\)
15b) \( f(x) < 0 \) \((-\infty, -3) \cup (1, 3)\)