1. Sketch the graph of the following polynomial function:
\[ f(x) = \frac{(x + 3)(x + 1)(x - 3)}{-4} \]

2. Sketch the graph of the following polynomial function:
\[ f(x) = \frac{(x + 3)(x - 1)(x - 2)}{-4} \]

3. Sketch the graph of the following polynomial function:
\[ f(x) = \frac{(x + 1)(x - 0)(x - 2)}{-4} \]

4. Sketch the graph of the following polynomial function:
\[ f(x) = \frac{(x + 3)(x + 2)(x - 2)}{2} \]

5. Sketch the graph of the following polynomial function:
\[ f(x) = \frac{(x + 1)(x - 2)(x - 3)}{-2} \]

6. Sketch the graph of the following polynomial function:
\[ f(x) = \frac{(x + 3)(x + 1)(x - 3)}{3} \]

7. Sketch the graph of the following polynomial function:
\[ f(x) = \frac{(x + 2)(x - 0)(x - 1)}{3} \]

8. Sketch the graph of the following polynomial function:
\[ f(x) = \frac{(x + 1)(x - 1)(x - 3)}{3} \]

9. Sketch the graph of the following polynomial function:
\[ f(x) = \frac{(x + 1)(x - 2)(x - 3)}{-5} \]

10. Sketch the graph of the following polynomial function:
\[ f(x) = \frac{(x + 3)(x + 2)(x + 1)}{-5} \]
Solutions:
1. \( f(x) = \frac{(x + 3)(x + 1)(x - 3)}{-4} \)

By expanding, \( f(x) = \frac{-9 - 9x + x^2 + x^3}{-4} \)

**Domain**
The function \( f(x) \) is a polynomial function. Therefore the domain is \( D_f = \mathbb{R} \).

**Symmetry**
\[ f(-x) = \frac{-9 - 9(-x) + (-x)^2 + (-x)^3}{-4} = \frac{-9 + 9x + x^2 - x^3}{-4} \]

\( f(-x) \neq f(x) \quad f(-x) \neq -f(x) \)

Therefore the function \( f(x) \) is neither even nor odd function.

**Zeros**
The zeros of the function \( f(x) \) are: \( x_1 = -3 \quad x_2 = -1 \quad x_3 = 3 \)

**y-intercept**
\( y \text{-int} = f(0) = \frac{-9}{-4} = 2.250 \)

**Asymptotes**
The function \( f(x) \) is a polynomial function of degree 3. Therefore the function does not have any kind of asymptotes.

**Critical Numbers**
\[ f'(x) = \frac{-9 + 2x + 3x^2}{-4} \]

Critical numbers are the solutions of the equation \( f'(x) = 0 \) or \( -9 + 2x + 3x^2 = 0 \)

\[ x = \frac{-2 \pm \sqrt{(-2)^2 - 4(3)(-9)}}{6} \]

\( x_4 = \frac{-2 - \sqrt{(112)}}{6} = -2.097 \quad y_4 = f(x_4) = -1.262 \)

\( x_5 = \frac{-2 + \sqrt{(112)}}{6} = 1.431 \quad y_5 = f(x_5) = 4.225 \)

**Sign Chart for the First Derivative \( f'(x) \)**

<table>
<thead>
<tr>
<th>( x )</th>
<th>-2.097</th>
<th>1.431</th>
</tr>
</thead>
<tbody>
<tr>
<td>( f(x) )</td>
<td>↓</td>
<td>↑</td>
</tr>
<tr>
<td>( f'(x) )</td>
<td>0</td>
<td>+</td>
</tr>
</tbody>
</table>

**Increasing and Decreasing Intervals**
The function \( f(x) \) is decreasing over \((-\infty, -2.097)\) and over \((1.431, \infty)\) and is increasing over \((-2.097, 1.431)\).

**Maximum and Minimum Points**
The function \( f(x) \) has a minimum point at \( P_4(-2.097, -1.262) \) and a maximum point at \( P_5(1.431, 4.225) \).

**Concavity Intervals**
The second derivative of the function \( f(x) \) is given by: \( f''(x) = \frac{2 + 6x}{-4} \)
The second derivative $f''(x)$ is zero when: $f''(x) = 0 \quad 2 + 6x = 0 \quad x_6 = \frac{-1}{3} \quad y_6 = f(x_6) = 1.481$

**Sign Chart for the Second Derivative $f''(x)$**

<table>
<thead>
<tr>
<th>$x$</th>
<th>-0.333</th>
</tr>
</thead>
<tbody>
<tr>
<td>$f(x)$</td>
<td>$\sim$ 1.481 $\nearrow$</td>
</tr>
<tr>
<td>$f''(x)$</td>
<td>$+$ 0 $-$</td>
</tr>
</tbody>
</table>

**Inflection Points**

There is an inflection point at $P_6 = (-0.333, 1.481)$

**Graph**

![Graph of the function with marked inflection points and critical points.](attachment:image.png)
2. \( f(x) = \frac{(x + 3)(x - 1)(x - 2)}{-4} \)

By expanding, \( f(x) = \frac{6 - 7x + x^3}{-4} \)

**Domain**
The function \( f(x) \) is a polynomial function. Therefore the domain is \( D_f = \mathbb{R} \).

**Symmetry**
\[ f(-x) = \frac{6 - 7(-x) + (-x)^3}{-4} = \frac{6 + 7x - x^3}{-4} \]

\( f(-x) \neq f(x) \quad f(-x) \neq -f(x) \)

Therefore the function \( f(x) \) is neither even nor odd function.

**Zeros**
The zeros of the function \( f(x) \) are: \( x_1 = -3 \quad x_2 = 1 \quad x_3 = 2 \)

**y-intercept**
\( y - int = f(0) = \frac{6}{-4} = -1.500 \)

**Asymptotes**
The function \( f(x) \) is a polynomial function of degree 3. Therefore the function does not have any kind of asymptotes.

**Critical Numbers**
\( f'(x) = \frac{-7 + 3x^2}{-4} \)

Critical numbers are the solutions of the equation \( f'(x) = 0 \) or \(-7 + 3x^2 = 0\)

\[ x = \frac{0 \pm \sqrt{(0)^2 - 4(3)(-7)}}{6} \]

\[ x_4 = \frac{0 - \sqrt{84}}{6} = -1.528 \quad y_4 = f(x_4) = -3.282 \]

\[ x_5 = \frac{0 + \sqrt{84}}{6} = 1.528 \quad y_5 = f(x_5) = 0.282 \]

**Sign Chart for the First Derivative \( f'(x) \)**

<table>
<thead>
<tr>
<th>( x )</th>
<th>-1.528</th>
<th>1.528</th>
</tr>
</thead>
<tbody>
<tr>
<td>( f'(x) )</td>
<td>↓ -3.282</td>
<td>↑ 0.282</td>
</tr>
<tr>
<td>( f(x) )</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Increasing and Decreasing Intervals**
The function \( f(x) \) is decreasing over \((-\infty, -1.528)\) and over \((1.528, \infty)\) and is increasing over \((-1.528, 1.528)\).

**Maximum and Minimum Points**
The function \( f(x) \) has a minimum point at \( P_4(-1.528, -3.282) \) and a maximum point at \( P_5(1.528, 0.282) \).

**Concavity Intervals**
The second derivative of the function \( f(x) \) is given by: \( f''(x) = \frac{6x}{-4} \)

The second derivative \( f''(x) \) is zero when: \( f''(x) = 0 \quad 6x = 0 \quad x_6 = 0 \quad y_6 = f(x_6) = -1.500 \)
Sign Chart for the Second Derivative $f''(x)$

<table>
<thead>
<tr>
<th>$x$</th>
<th>0.000</th>
</tr>
</thead>
<tbody>
<tr>
<td>$f(x)$</td>
<td>$\sim$ $-1.500$ $\sim$</td>
</tr>
<tr>
<td>$f''(x)$</td>
<td>$+$ $0$ $-$</td>
</tr>
</tbody>
</table>

**Inflection Points**
There is an inflection point at $P_6 = (0.000, -1.500)$

**Graph**

![Graph of the function showing points and axes]
3. \( f(x) = \frac{(x + 1)(x - 0)(x - 2)}{-4} \)

By expanding, \( f(x) = \frac{-2x - x^2 + x^3}{-4} \)

**Domain**
The function \( f(x) \) is a polynomial function. Therefore the domain is \( D_f = \mathbb{R} \).

**Symmetry**
\[
\begin{align*}
 f(-x) &= \frac{-2(-x) - (-x)^2 + (-x)^3}{-4} = \frac{2x - x^2 - x^3}{-4} \\
 f(-x) &\neq f(x) \quad f(-x) \neq -f(x)
\end{align*}
\]
Therefore the function \( f(x) \) is neither even nor odd function.

**Zeros**
The zeros of the function \( f(x) \) are: \( x_1 = -1 \quad x_2 = 0 \quad x_3 = 2 \)

**y-intercept**
\[
y - \text{int} = f(0) = \frac{0}{-4} = 0.000
\]

**Asymptotes**
The function \( f(x) \) is a polynomial function of degree 3. Therefore the function does not have any kind of asymptotes.

**Critical Numbers**
\[
f'(x) = \frac{-2 - 2x + 3x^2}{-4}
\]
Critical numbers are the solutions of the equation \( f'(x) = 0 \quad \text{or} \quad -2 - 2x + 3x^2 = 0 \)
\[
\begin{align*}
 x &= \frac{2 \pm \sqrt{(2)^2 - 4(3)(-2)}}{6} \\
 x_4 &= \frac{2 - \sqrt{28}}{6} = -0.549 \quad y_4 = f(x_4) = -0.158 \\
 x_5 &= \frac{2 + \sqrt{28}}{6} = 1.215 \quad y_5 = f(x_5) = 0.528
\end{align*}
\]

**Sign Chart for the First Derivative \( f'(x) \)**

<table>
<thead>
<tr>
<th>( x )</th>
<th>(-0.549)</th>
<th>( 1.215 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( f(x) )</td>
<td>↓</td>
<td>(-0.158)</td>
</tr>
<tr>
<td>( f'(x) )</td>
<td>-</td>
<td>0</td>
</tr>
</tbody>
</table>

**Increasing and Decreasing Intervals**
The function \( f(x) \) is decreasing over \(( -\infty, -0.549)\) and over \((1.215, \infty)\) and is increasing over \((-0.549, 1.215)\).

**Maximum and Minimum Points**
The function \( f(x) \) has a minimum point at \( P_4(-0.549, -0.158) \) and a maximum point at \( P_5(1.215, 0.528) \).

**Concavity Intervals**
The second derivative of the function \( f(x) \) is given by: \( f''(x) = \frac{-2 + 6x}{-4} \)
The second derivative \( f''(x) \) is zero when:

\[
-2 + 6x = 0 \quad \Rightarrow \quad x = \frac{1}{3}
\]

\[
y_6 = f(x_6) = 0.185
\]

**Sign Chart for the Second Derivative \( f''(x) \)**

<table>
<thead>
<tr>
<th>( x )</th>
<th>0.333</th>
</tr>
</thead>
<tbody>
<tr>
<td>( f(x) )</td>
<td>↘ 0.185 ↗</td>
</tr>
<tr>
<td>( f''(x) )</td>
<td>+ 0 −</td>
</tr>
</tbody>
</table>

**Inflection Points**

There is an inflection point at \( P_6 = (0.333, 0.185) \)

**Graph**
4. \( f(x) = \frac{(x + 3)(x + 2)(x - 2)}{2} \)

By expanding, \( f(x) = \frac{-12 - 4x + 3x^2 + x^3}{2} \)

**Domain**
The function \( f(x) \) is a polynomial function. Therefore the domain is \( D_f = \mathbb{R} \).

**Symmetry**

\[
\begin{align*}
  f(-x) &= \frac{-12 - 4(-x) + 3((-x)^2) + (-x)^3}{2} = \frac{-12 + 4x + 3x^2 - x^3}{2} \\
  f(-x) &\neq f(x) \quad f(-x) &\neq -f(x)
\end{align*}
\]

Therefore the function \( f(x) \) is neither even nor odd function.

**Zeros**
The zeros of the function \( f(x) \) are: \( x_1 = -3 \quad x_2 = -2 \quad x_3 = 2 \)

**y-intercept**
\[
y - \text{int} = f(0) = \frac{-12}{2} = -6.00
\]

**Asymptotes**
The function \( f(x) \) is a polynomial function of degree 3. Therefore the function does not have any kind of asymptotes.

**Critical Numbers**
\[
f'(x) = \frac{-4 + 6x + 3x^2}{2}
\]

Critical numbers are the solutions of the equation \( f'(x) = 0 \) or \(-4 + 6x + 3x^2 = 0\)

\[
x = \frac{-6 \pm \sqrt{(-6)^2 - 4(3)(-4)}}{6}
\]

\[
x_4 = \frac{-6 - \sqrt{84}}{6} = -2.528 \quad y_4 = f(x_4) = 0.564
\]

\[
x_5 = \frac{-6 + \sqrt{84}}{6} = 0.528 \quad y_5 = f(x_5) = -6.564
\]

**Sign Chart for the First Derivative \( f'(x) \)**

<table>
<thead>
<tr>
<th>( x )</th>
<th>-2.528</th>
<th>0.528</th>
</tr>
</thead>
<tbody>
<tr>
<td>( f(x) )</td>
<td>↑ 0.564</td>
<td>↓ -6.564</td>
</tr>
<tr>
<td>( f'(x) )</td>
<td>+ 0</td>
<td>- 0</td>
</tr>
</tbody>
</table>

**Increasing and Decreasing Intervals**
The function \( f(x) \) is increasing over \((-\infty, -2.528)\) and over \((0.528, \infty)\) and is decreasing over \((-2.528, 0.528)\).

**Maximum and Minimum Points**
The function \( f(x) \) has a maximum point at \( P_4(-2.528, 0.564) \) and a minimum point at \( P_5(0.528, -6.564) \).

**Concavity Intervals**
The second derivative of the function \( f(x) \) is given by: \( f''(x) = \frac{6 + 6x}{2} \)

The second derivative \( f''(x) \) is zero when: \( f''(x) = 0 \quad 6 + 6x = 0 \quad x_6 = -1 \quad y_6 = f(x_6) = -3.000 \)
**Sign Chart for the Second Derivative $f''(x)$**

<table>
<thead>
<tr>
<th>$x$</th>
<th>$-1.000$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$f(x)$</td>
<td>$-3.000$</td>
</tr>
<tr>
<td>$f''(x)$</td>
<td>$0$</td>
</tr>
</tbody>
</table>

**Inflection Points**
There is an inflection point at $P_6 = (-1.000, -3.000)$

**Graph**
5. \( f(x) = \frac{(x+1)(x-2)(x-3)}{-2} \)

By expanding, \( f(x) = \frac{6 + x - 4x^2 + x^3}{-2} \)

**Domain**

The function \( f(x) \) is a polynomial function. Therefore the domain is \( D_f = \mathbb{R} \).

**Symmetry**

\[
 f(-x) = \frac{6 + (-x) - 4(-x)^2 + (-x)^3}{-2} = \frac{6 - x - 4x^2 - x^3}{-2}
\]

\( f(-x) \neq f(x) \quad f(-x) \neq -f(x) \)

Therefore the function \( f(x) \) is neither even nor odd function.

**Zeros**

The zeros of the function \( f(x) \) are: \( x_1 = -1 \quad x_2 = 2 \quad x_3 = 3 \)

**y-intercept**

\( y - \text{int} = f(0) = \frac{6}{-2} = -3.000 \)

**Asymptotes**

The function \( f(x) \) is a polynomial function of degree 3. Therefore the function does not have any kind of asymptotes.

**Critical Numbers**

\[
 f'(x) = \frac{1 - 8x + 3x^2}{-2}
\]

Critical numbers are the solutions of the equation \( f'(x) = 0 \) or \( 1 - 8x + 3x^2 = 0 \)

\[
x = \frac{8 \pm \sqrt{(8)^2 - 4(3)(1)}}{6}
\]

\[
x_4 = \frac{8 - \sqrt{52}}{6} = 0.131 \quad y_4 = f(x_4) = -3.032
\]

\[
x_5 = \frac{8 + \sqrt{52}}{6} = 2.535 \quad y_5 = f(x_5) = 0.440
\]

**Sign Chart for the First Derivative \( f'(x) \)**

<table>
<thead>
<tr>
<th>( x )</th>
<th>0.131</th>
<th>2.535</th>
</tr>
</thead>
<tbody>
<tr>
<td>( f(x) )</td>
<td>↓</td>
<td>-3.032</td>
</tr>
<tr>
<td>( f'(x) )</td>
<td>-</td>
<td>0</td>
</tr>
</tbody>
</table>

**Increasing and Decreasing Intervals**

The function \( f(x) \) is decreasing over \((-\infty, 0.131)\) and over \((2.535, \infty)\) and is increasing over \((0.131, 2.535)\).

**Maximum and Minimum Points**

The function \( f(x) \) has a minimum point at \( P_4(0.131, -3.032) \) and a maximum point at \( P_5(2.535, 0.440) \).

**Concavity Intervals**

The second derivative of the function \( f(x) \) is given by: \( f''(x) = \frac{-8 + 6x}{-2} \)
The second derivative $f''(x)$ is zero when: $f''(x) = 0 \quad -8 + 6x = 0 \quad x_6 = \frac{4}{3} \quad y_6 = f(x_6) = -1.296$

**Sign Chart for the Second Derivative $f''(x)$**

<table>
<thead>
<tr>
<th>$x$</th>
<th>1.333</th>
</tr>
</thead>
<tbody>
<tr>
<td>$f(x)$</td>
<td>$\sim$</td>
</tr>
<tr>
<td>$f''(x)$</td>
<td>$+$</td>
</tr>
</tbody>
</table>

**Inflection Points**
There is an inflection point at $P_6 = (1.333, -1.296)$

**Graph**
6. \( f(x) = \frac{(x + 3)(x + 1)(x - 3)}{3} \)

By expanding, \( f(x) = \frac{-9 - 9x + x^2 + x^3}{3} \)

**Domain**
The function \( f(x) \) is a polynomial function. Therefore the domain is \( D_f = \mathbb{R} \).

**Symmetry**
\[
\begin{align*}
 f(-x) &= \frac{-9 - 9(-x) + (-x)^2 + (-x)^3}{3} = \frac{-9 + 9x + x^2 - x^3}{3} \\
 f(-x) &\neq f(x) \quad f(-x) &\neq -f(x)
\end{align*}
\]
Therefore the function \( f(x) \) is neither even nor odd function.

**Zeros**
The zeros of the function \( f(x) \) are: \( x_1 = -3 \quad x_2 = -1 \quad x_3 = 3 \)

**y-intercept**
\( y-int = f(0) = \frac{-9}{3} = -3.000 \)

**Asymptotes**
The function \( f(x) \) is a polynomial function of degree 3. Therefore the function does not have any kind of asymptotes.

**Critical Numbers**
\[
 f'(x) = \frac{-9 + 2x + 3x^2}{3}
\]

Critical numbers are the solutions of the equation \( f'(x) = 0 \) or \( -9 + 2x + 3x^2 = 0 \)
\[
x = \frac{-2 \pm \sqrt{(-2)^2 - 4(3)(-9)}}{6}
\]
\[
x_4 = \frac{-2 - \sqrt{(112)}}{6} = -2.097 \quad y_4 = f(x_4) = 1.683
\]
\[
x_5 = \frac{-2 + \sqrt{(112)}}{6} = 1.431 \quad y_5 = f(x_5) = -5.634
\]

**Sign Chart for the First Derivative \( f'(x) \)**

<table>
<thead>
<tr>
<th>( x )</th>
<th>( -2.097 )</th>
<th>1.431</th>
</tr>
</thead>
<tbody>
<tr>
<td>( f(x) )</td>
<td>↑</td>
<td>↓</td>
</tr>
<tr>
<td>( f'(x) )</td>
<td>+</td>
<td>0</td>
</tr>
</tbody>
</table>

**Increasing and Decreasing Intervals**
The function \( f(x) \) is increasing over \((-\infty, -2.097)\) and over \((1.431, \infty)\) and is decreasing over \((-2.097, 1.431)\).

**Maximum and Minimum Points**
The function \( f(x) \) has a maximum point at \( P_4(-2.097, 1.683) \) and a minimum point at \( P_5(1.431, -5.634) \).

**Concavity Intervals**
The second derivative of the function \( f(x) \) is given by: \( f''(x) = \frac{2 + 6x}{3} \)
The second derivative \( f''(x) \) is zero when: \( f''(x) = 0 \quad 2 + 6x = 0 \quad x_6 = \frac{-1}{3} \quad y_6 = f(x_6) = -1.975 \)
Sign Chart for the Second Derivative $f''(x)$

<table>
<thead>
<tr>
<th>$x$</th>
<th>$-0.333$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$f(x)$</td>
<td>$-1.975$</td>
</tr>
<tr>
<td>$f''(x)$</td>
<td>$0$</td>
</tr>
</tbody>
</table>

Inflection Points
There is an inflection point at $P_6 = (-0.333, -1.975)$

Graph
7. \( f(x) = \frac{(x + 2)(x - 0)(x - 1)}{3} \)

By expanding, \( f(x) = \frac{-2x + x^2 + x^3}{3} \)

**Domain**
The function \( f(x) \) is a polynomial function. Therefore the domain is \( D_f = \mathbb{R} \).

**Symmetry**
\[ f(-x) = \frac{-2(-x) + (-x)^2 + (-x)^3}{3} = \frac{2x + x^2 - x^3}{3} \]

\( f(-x) \neq f(x) \quad f(-x) \neq -f(x) \)

Therefore the function \( f(x) \) is neither even nor odd function.

**Zeros**
The zeros of the function \( f(x) \) are: \( x_1 = -2 \quad x_2 = 0 \quad x_3 = 1 \)

**y-intercept**
\( y \text{-int} = f(0) = \frac{0}{3} = 0.000 \)

**Asymptotes**
The function \( f(x) \) is a polynomial function of degree 3. Therefore the function does not have any kind of asymptotes.

**Critical Numbers**
\[ f'(x) = \frac{-2 + 2x + 3x^2}{3} \]

Critical numbers are the solutions of the equation \( f'(x) = 0 \) or \(-2 + 2x + 3x^2 = 0\)

\[ x = \frac{-2 \pm \sqrt{(-2)^2 - 4(3)(-2)}}{6} \]

\[ x_4 = \frac{-2 - \sqrt{28}}{6} = -1.215 \quad y_4 = f(x_4) = 0.704 \]

\[ x_5 = \frac{-2 + \sqrt{28}}{6} = 0.549 \quad y_5 = f(x_5) = -0.210 \]

**Sign Chart for the First Derivative \( f'(x) \)**

<table>
<thead>
<tr>
<th>( x )</th>
<th>(-1.215)</th>
<th>( 0.549)</th>
</tr>
</thead>
<tbody>
<tr>
<td>( f(x) )</td>
<td>↑</td>
<td>↓</td>
</tr>
<tr>
<td>( f'(x) )</td>
<td>+</td>
<td>-</td>
</tr>
</tbody>
</table>

**Increasing and Decreasing Intervals**
The function \( f(x) \) is increasing over \((-\infty, -1.215)\) and over \((0.549, \infty)\) and is decreasing over \((-1.215, 0.549)\).

**Maximum and Minimum Points**
The function \( f(x) \) has a maximum point at \( P_4(-1.215, 0.704) \) and a minimum point at \( P_5(0.549, -0.210) \).

**Concavity Intervals**
The second derivative of the function \( f(x) \) is given by: \( f''(x) = \frac{2 + 6x}{3} \)

The second derivative \( f''(x) \) is zero when: \( f''(x) = 0 \quad 2 + 6x = 0 \quad x_6 = \frac{-1}{3} \quad y_6 = f(x_6) = 0.247 \)
Sign Chart for the Second Derivative $f''(x)$

<table>
<thead>
<tr>
<th>$x$</th>
<th>$-0.333$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$f(x)$</td>
<td>$0.247$</td>
</tr>
<tr>
<td>$f''(x)$</td>
<td>$+$</td>
</tr>
</tbody>
</table>

Inflection Points
There is an inflection point at $P_0 = (-0.333, 0.247)$

Graph
8. \( f(x) = \frac{(x + 1)(x - 1)(x - 3)}{3} \)

By expanding, \( f(x) = \frac{3 - x - 3x^2 + x^3}{3} \)

**Domain**
The function \( f(x) \) is a polynomial function. Therefore the domain is \( D_f = \mathbb{R} \).

**Symmetry**
\[
f(-x) = \frac{3 - (-x) - 3(-x)^2 + (-x)^3}{3} = \frac{3 + x - 3x^2 - x^3}{3}
\]

\( f(-x) \neq f(x) \quad f(-x) \neq -f(x) \)

Therefore the function \( f(x) \) is neither even nor odd function.

**Zeros**
The zeros of the function \( f(x) \) are: \( x_1 = -1 \quad x_2 = 1 \quad x_3 = 3 \)

**y-intercept**
\( y \text{-int} = f(0) = \frac{3}{3} = 1.000 \)

**Asymptotes**
The function \( f(x) \) is a polynomial function of degree 3. Therefore the function does not have any kind of asymptotes.

**Critical Numbers**
\[
f'(x) = \frac{-1 - 6x + 3x^2}{3}
\]

Critical numbers are the solutions of the equation \( f'(x) = 0 \) or \( -1 - 6x + 3x^2 = 0 \)

\[
x = \frac{6 \pm \sqrt{(6)^2 - 4(3)(-1)}}{6}
\]

\[
x_4 = \frac{6 - \sqrt{48}}{6} = -0.155 \quad y_4 = f(x_4) = 1.026
\]

\[
x_5 = \frac{6 + \sqrt{48}}{6} = 2.155 \quad y_5 = f(x_5) = -1.026
\]

**Sign Chart for the First Derivative \( f'(x) \)**

<table>
<thead>
<tr>
<th>( x )</th>
<th>-0.155</th>
<th>2.155</th>
</tr>
</thead>
<tbody>
<tr>
<td>( f(x) )</td>
<td>↑</td>
<td>1.026</td>
</tr>
<tr>
<td>( f'(x) )</td>
<td>+</td>
<td>0</td>
</tr>
</tbody>
</table>

**Increasing and Decreasing Intervals**
The function \( f(x) \) is increasing over \((-\infty, -0.155)\) and over \((2.155, \infty)\) and is decreasing over \((-0.155, 2.155)\).

**Maximum and Minimum Points**
The function \( f(x) \) has a maximum point at \( P_4(-0.155, 1.026) \) and a minimum point at \( P_5(2.155, -1.026) \).

**Concavity Intervals**
The second derivative of the function \( f(x) \) is given by: \( f''(x) = \frac{-6 + 6x}{3} \)

The second derivative \( f''(x) \) is zero when: \( f''(x) = 0 \quad -6 + 6x = 0 \quad x_6 = 1 \quad y_6 = f(x_6) = 0.000 \)
Sign Chart for the Second Derivative $f''(x)$

<table>
<thead>
<tr>
<th>$x$</th>
<th>1.000</th>
</tr>
</thead>
<tbody>
<tr>
<td>$f(x)$</td>
<td>$\nearrow 0.000 \searrow$</td>
</tr>
<tr>
<td>$f''(x)$</td>
<td>$-0 +$</td>
</tr>
</tbody>
</table>

**Inflection Points**
There is an inflection point at $P_6 = (1.000, 0.000)$

**Graph**

![Graph of a curve with marked points and axes labeled x and y.](image-url)
9. \( f(x) = \frac{(x+1)(x-2)(x-3)}{-5} \)

By expanding, \( f(x) = \frac{6 + x - 4x^2 + x^3}{-5} \)

**Domain**
The function \( f(x) \) is a polynomial function. Therefore the domain is \( D_f = \mathbb{R} \).

**Symmetry**
\( f(-x) = \frac{6 + (-x) - 4(-x)^2 + (-x)^3}{-5} = \frac{6 - x - 4x^2 - x^3}{-5} \)

\( f(-x) \neq f(x) \quad f(-x) \neq -f(x) \)

Therefore the function \( f(x) \) is neither even nor odd function.

**Zeros**
The zeros of the function \( f(x) \) are: \( x_1 = -1 \quad x_2 = 2 \quad x_3 = 3 \)

**y-intercept**
\( y = f(0) = \frac{6}{-5} = -1.200 \)

**Asymptotes**
The function \( f(x) \) is a polynomial function of degree 3. Therefore the function does not have any kind of asymptotes.

**Critical Numbers**
\( f'(x) = \frac{1 - 8x + 3x^2}{-5} \)

Critical numbers are the solutions of the equation \( f'(x) = 0 \quad \text{or} \quad 1 - 8x + 3x^2 = 0 \)

\( x = \frac{8 \pm \sqrt{(8)^2 - 4(3)(1)}}{6} \)

\( x_4 = \frac{8 - \sqrt{52}}{6} = 0.131 \quad y_4 = f(x_4) = -1.213 \)

\( x_5 = \frac{8 + \sqrt{52}}{6} = 2.535 \quad y_5 = f(x_5) = 0.176 \)

**Sign Chart for the First Derivative \( f'(x) \)**

<table>
<thead>
<tr>
<th>( x )</th>
<th>0.131</th>
<th>2.535</th>
</tr>
</thead>
<tbody>
<tr>
<td>( f(x) )</td>
<td>↓ 1.213</td>
<td>↑ 0.176</td>
</tr>
<tr>
<td>( f'(x) )</td>
<td>- 0 + 0 -</td>
<td></td>
</tr>
</tbody>
</table>

**Increasing and Decreasing Intervals**
The function \( f(x) \) is decreasing over \(( -\infty, 0.131) \) and over \((2.535, \infty) \) and is increasing over \((0.131, 2.535) \).

**Maximum and Minimum Points**
The function \( f(x) \) has a minimum point at \( P_4(0.131, -1.213) \) and a maximum point at \( P_5(2.535, 0.176) \).

**Concavity Intervals**
The second derivative of the function \( f(x) \) is given by: \( f''(x) = \frac{-8 + 6x}{-5} \)
The second derivative \( f''(x) \) is zero when: \( f''(x) = 0 \quad -8 + 6x = 0 \quad x_6 = \frac{4}{3} \quad y_6 = f(x_6) = -0.519 \\

**Sign Chart for the Second Derivative \( f''(x) \)**

<table>
<thead>
<tr>
<th>( x )</th>
<th>1.333</th>
</tr>
</thead>
<tbody>
<tr>
<td>( f(x) )</td>
<td>&lt; -0.519 &gt;</td>
</tr>
<tr>
<td>( f''(x) )</td>
<td>+ 0 &lt;</td>
</tr>
</tbody>
</table>

**Inflection Points**  
There is an inflection point at \( P_6 = (1.333, -0.519) \)

**Graph**
10. \( f(x) = \frac{(x + 3)(x + 2)(x + 1)}{-5} \)

By expanding, \( f(x) = \frac{6 + 11x + 6x^2 + x^3}{-5} \)

**Domain**

The function \( f(x) \) is a polynomial function. Therefore the domain is \( D_f = \mathbb{R} \).

**Symmetry**

\[
\begin{align*}
  f(-x) &= \frac{6 + 11(-x) + 6(-x)^2 + (-x)^3}{-5} \\
  &= \frac{6 - 11x + 6x^2 - x^3}{-5}
\end{align*}
\]

\( f(-x) \neq f(x) \quad f(-x) \neq -f(x) \)

Therefore the function \( f(x) \) is neither even nor odd function.

**Zeros**

The zeros of the function \( f(x) \) are: \( x_1 = -3 \quad x_2 = -2 \quad x_3 = -1 \)

**y-intercept**

\( y - int = f(0) = \frac{6}{-5} = -1.200 \)

**Asymptotes**

The function \( f(x) \) is a polynomial function of degree 3. Therefore the function does not have any kind of asymptotes.

**Critical Numbers**

\[
\begin{align*}
  f'(x) &= \frac{11 + 12x + 3x^2}{-5}
\end{align*}
\]

Critical numbers are the solutions of the equation \( f'(x) = 0 \) or \( 11 + 12x + 3x^2 = 0 \)

\[
\begin{align*}
  x &= \frac{-12 \pm \sqrt{(-12)^2 - 4(3)(11)}}{6} \\
  &= \frac{-12 \pm \sqrt{144 - 132}}{6} \\
  &= \frac{-12 \pm \sqrt{12}}{6} \\
  x_4 &= \frac{-12 - \sqrt{12}}{6} = -2.577 \quad y_4 = f(x_4) = -0.077 \\
  x_5 &= \frac{-12 + \sqrt{12}}{6} = -1.423 \quad y_5 = f(x_5) = 0.077
\end{align*}
\]

**Sign Chart for the First Derivative \( f'(x) \)**

<table>
<thead>
<tr>
<th>( x )</th>
<th>-2.577</th>
<th>-1.423</th>
</tr>
</thead>
<tbody>
<tr>
<td>( f'(x) )</td>
<td>↓</td>
<td>↑</td>
</tr>
<tr>
<td>( f(x) )</td>
<td>↓</td>
<td>↑</td>
</tr>
</tbody>
</table>

**Increasing and Decreasing Intervals**

The function \( f(x) \) is decreasing over \((-\infty, -2.577)\) and over \((-1.423, \infty)\) and is increasing over \((-2.577, -1.423)\).

**Maximum and Minimum Points**

The function \( f(x) \) has a minimum point at \( P_4(-2.577, -0.077) \) and a maximum point at \( P_5(-1.423, 0.077) \).

**Concavity Intervals**

The second derivative of the function \( f(x) \) is given by: \( f''(x) = \frac{12 + 6x}{-5} \)

The second derivative \( f''(x) \) is zero when: \( f''(x) = 0 \quad 12 + 6x = 0 \quad x_6 = -2 \quad y_6 = f(x_6) = 0.000 \)
Sign Chart for the Second Derivative $f''(x)$

<table>
<thead>
<tr>
<th>$x$</th>
<th>$-2.000$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$f(x)$</td>
<td>0.000</td>
</tr>
<tr>
<td>$f''(x)$</td>
<td>$+$ $0$ $-$</td>
</tr>
</tbody>
</table>

Inflection Points
There is an inflection point at $P_0 = (-2.000, 0.000)$

Graph