Weilbaden, 6 August, 2015  If we think about lightweight design in automotive engineering, then the focus is predominantly on the use of lightweight materials such as aluminium, carbon, magnesium or fibre composites. But are the lightweight design approaches applied to date really enough to achieve the ambitious weight and emissions targets for the sustainable vehicles for our future mobility? What would happen if development engineers were to allow themselves to be inspired by Nature, the leading expert in lightweight, efficient and sustainable design? Engineering service provider EDAG will be providing the answer at the IAA ‘15, with the German premiere of its concept car “EDAG Light Cocoon”. A vehicle that takes the bionics pattern of a leaf as its design basis, and converts it into the ultimate in lightweight, intelligently networked body structures. A concept that illustrates sustainable methods for the automotive industry and at the same time shows the technological potential of additive manufacturing.
3-7 Investigating Graphs of Polynomial functions


Notes

### Graphs of Polynomial Functions

<table>
<thead>
<tr>
<th></th>
<th>Linear</th>
<th>Quadratic</th>
<th>Cubic</th>
<th>Quartic</th>
<th>Quintic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Degree</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

End Behavior: Describes the behavior of the graph at its extreme values for $x \rightarrow \infty$, $x \rightarrow -\infty$.

**Polynomial End Behavior**

<table>
<thead>
<tr>
<th>$f(x)$ behavior</th>
<th>Odd Degree: 1, 3, 5, ...</th>
<th>Even Degree: 2, 4, 6, ...</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leading coefficient $a &gt; 0$</td>
<td>$+LC$</td>
<td>$x \rightarrow \infty$, $y \rightarrow \infty$</td>
</tr>
<tr>
<td>Leading coefficient $a &lt; 0$</td>
<td>$-LC$</td>
<td>$x \rightarrow -\infty$, $y \rightarrow -\infty$</td>
</tr>
</tbody>
</table>

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Example 1. Determining End Behavior of Polynomial Functions
Identify the leading coefficient, degree, and end behavior.

A. \( P(x) = -4x^3 - 3x^2 + 5x + 6 \)
   - LC: -4, deg: 3
   - \( R: x \to \infty, y \to -\infty \)
   - \( L: x \to -\infty, y \to \infty \)

B. \( R(x) = x^5 - 7x^3 + x^2 - 2 \)
   - LC: 1, deg: 6
   - \( R: x \to \infty, y \to \infty \)
   - \( L: x \to -\infty, y \to \infty \)

C. \( p(x) = 2x^5 + 3x^2 - 4x - 1 \)
   - LC: 2, deg: 5
   - \( R: x \to \infty, y \to \infty \)
   - \( L: x \to -\infty, y \to -\infty \)

D. \( S(x) = -3x^2 + x + 1 \)

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Why did the function \( f(x) = -x^2 \) finally get kicked out of class?

In the end, its behavior was just too negative.
Example 2. Using Graphs to Analyze Polynomial Functions

Identify whether the function graphed has an odd or even degree and a positive or negative leading coefficient.

2a.

2b.

Even degree

Steps for Graphing a Polynomial Function

1. Find the real zeros and y-intercept of the function
2. Plot the x- and y-intercepts
3. Make a table for several x-values that lie between the real zeros
4. Plot the points from your table
5. Determine the end behavior of the graph
6. Sketch the graph
Example 3 Graphing Polynomial Functions

Graph the function.

\[ f(x) = x^3 + 3x^2 - 6x - 8 \]

real zeros: \( x = \{ \frac{2}{3}, -1, -4 \} \)

- \( y \)-int: \(-8\)
- 1st. Generate
  - Constant: \(-8\) \(\frac{1}{2}, 4, 8\)
  - LC: \(1\)
  - List: \(1, 2, 4, 8\)

\[
\begin{array}{c|c|c|c|c}
2 & 1 & 3 & -6 & -8 \\
1 & 2 & 10 & 8 \\
\end{array}
\]

\[ 2x^2 + 5x + 4 = 0 \]
\[ (x+1)(x+4) = 0 \]
\[ x = -1, x = -4 \]

One more add:
\[ f(-2) = (-2)^3 + 3(-2)^2 - 6(-2) - 8 \]
\[ = -8 + 12 + 12 - 8 \]
\[ f(-2) = 8 \rightarrow (-2, 8) \]

Example 3A Graphing the function.

\[ f(x) = x^2 - 2x^2 - 5x + 6 \]

real zeros: \( x = \{-2, 1, 3\} \)

- \( y \)-int: \(6\)
- Constant: \(6\) \(\frac{1}{2}, 3, 6\)
- LC: \(1\)
- List: \(1, 2, 3, 6\)

\[
\begin{array}{c|c|c|c|c|c}
-2 & 1 & -2 & -5 & 6 \\
1 & -2 & 8 & -6 \\
\end{array}
\]

\[ x^2 - 4x + 3 = 0 \]
\[ (x-1)(x-3) = 0 \]
Example 3C
Graph the function.

\[ f(x) = -2x^2 - x + 6 \]