Project 1: Designing a Roller Coaster

Douglas Meade, Ronda Sanders, and Xian Wu
Department of Mathematics

Preparation

Be sure to read the *Project Report Guidelines* before beginning your project. Remember, you are to turn in a neat and complete project report. Any figures should have a title and a legend and be properly referenced in the report. Do not turn in a Maple worksheet. A complete project report should include all necessary equations and information.

The Problem

Suppose you are asked to build a larger roller coaster with an overall horizontal displacement of 500 feet. The coaster should ascend along a straight line $y = f1(x)$ of slope 3 for the first 50ft horizontally. We continue along three cubics, $f2(x) = ax^3+bx^2+cx+d$, $f3(x) = ex^3 + fx^2 + gx + h$, and $f4(x) = ix^3 + jx^2 + kx + l$ for 125ft each. In addition, the coaster should be 220ft above the ground at the 125ft mark, reach a bottom (local minimum) of 65ft above the ground at 225ft horizontally, and reach a peak (local maximum) of 150ft above the ground at 345ft horizontally. Finally, the coaster should start a soft landing 60ft above the ground along a cubic $f5(x) = mx^3 + nx^2 + ox + p$ for the last 75ft.

Your Tasks

1. Write a system of 16 equations in 16 unknowns such that your track is both continuous and smooth throughout.
   Note: *You must explain the reasoning for your equations within your report. Be sure to include your equations in your report.*
2. Solve the equations in (1) with Maple to find values for *a*-*p*.
3. Define and plot a piecewise-defined function, $F(x)$, for your roller coaster.
   Note: *Include the equation for your completed piecewise-defined function (with all values a-p plugged in) as well as the graph of your roller coaster. Be sure to use the same scale for both x and y.*
4. Find the maximum height of your roller coaster.