

Project 1: Designing a Roller Coaster

Douglas Meade, Ronda Sanders and Xian Wu

Department of Mathematics

Preparation

Be sure to read *What is a Project Report?* 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!** All projects should be written using Microsoft Word.

The Problem

Suppose you are asked to build a larger roller coaster with an overall horizontal displacement of 400 feet. The coaster should ascend along a straight line $y = f_1(x)$ of slope 2 for the first 20ft horizontally. We continue along three cubics, $f_2(x) = ax^3 + bx^2 + cx + d$, $f_3(x) = ex^3 + fx^2 + gx + h$, and $f_4(x) = ix^3 + jx^2 + kx + l$ for 100ft each. In addition, the coaster should be 100ft above the ground at the 80ft mark, reach a bottom of 10ft above the ground at 180ft horizontally, and reach a peak 65ft above the ground at 260ft horizontally. Finally, the coaster should start a soft landing 20ft above the ground along a cubic $f_5(x) = mx^3 + nx^2 + ox + p$ for the last 80ft.

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.
2. Solve the equations in (1) with Maple to find formulas for $f_1, f_2, f_3, f_4,$ and f_5 .
Note: You must include the complete equations for every function in your report.
3. Define and plot a piecewise-defined function, $F(x)$, for your roller coaster.
Note: Also include your completed piecewise-defined function in your report.
4. Find the maximum height of your roller coaster.