

Project: Designing a Roller Coaster

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Preparation

Be sure to read *Project Report/Grading Guideline* 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 just turn in a Maple worksheet as a complete report in your own word is required.

The Problem

Suppose you are asked to build a roller coaster with an overall horizontal displacement of 600 feet. The coaster should ascend along a straight line $y = f_1(x)$ of slope 2.5 for the first 30ft 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 150ft each. In addition, the coaster should be 210ft above the ground at the 120ft mark, reach a bottom of 37.5ft above the ground at the 270ft mark, and reach a peak 97.5ft above the ground at the 390ft mark. Finally, the coaster should start a soft landing 45ft above the ground along a cubic $f_5(x) = mx^3 + nx^2 + ox + p$ for the last 120ft.

Your Tasks

1. Write a system of 16 equations in 16 unknowns such that your track is both continuous and smooth throughout.

Note: Be sure to include your equations in your report and you must explain the reasoning for your equations within 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 scalar for both x and y .
4. Find the maximum height of your roller coaster and the mark where it occurred.
5. Your Maple worksheet for this project will be due **one week** from the day you complete Lab J. The written report will be due **one week** after that.

Extra Credit

Design a more interesting roller coaster of your own.