Math 251 **The Roller Coaster Project** **Fall 2016**

You have been hired by Charlie's Entertainment to design a new roller coaster for "Inverse Land". Your group will write a *formal,* type written report describing your design, and explaining why Charlie's Entertainment should choose your roller coaster. Essentially, they want a viable design with the most thrill for the money. Your report must be typed written with 12-point font minimum. *The NEATLY hand written work showing mathematical calculations will be included as an addendum*. The report is not limited to, but must include the following. **Also, see the Project Scoring Sheet for more details.**

- Title and names of group members
- A brief introduction on how you went about coming up with your design – the shape and key features, not the equations.
- The equations of the entire ride (**including interval of definition for each equation**) and work showing how they were derived (the actual work must be neatly written and included in your addendum). Include verbal descriptions.
- An accurate calculation of the cost for the materials needed to build the supports, including an explanation of how you did the calculations.
- An accurate calculation of the thrill of your ride, including an explanation of how you did the calculations.
- A computer generated graph of your entire roller coaster. You can go to: http://math.exeter.edu/rparris/winplot.html to download a free version of Winplot. You will need to get prior instructor approval to use a different software package.
- Summary of why your design should be selected by Charlie's Entertainment. This is where you get to be creative and sell your work!

This project will represent 10% of your course grade. It will be graded on completeness and neatness, as well as accuracy (see the scoring sheet for details). **The project is due, with at least 2 names on it, Monday, week 10, for 5% bonus; Wed. for 3% bonus; and Fri for 1% bonus**. **The absolute last day I will accept the project is Wed. Dec. 7, 5pm, finals week.** Solo labs will receive 5% penalty; part of the learning process requires that you are able to communicate your mathematical concepts with your colleagues. You should do this project in groups of 2 or 3, with a maximum of 5 people to be considered for any bonus pts and to minimize your work load. I am also asking you to assess your group members on their participation. We may have time to work on this project during part of one or two class days, but you will definitely need to schedule group time outside of class. The biggest mistake you could make on this project is leaving the write-up and thrill and support calculations till too late -- make sure you give yourself enough time to write up a good, formal, proof-read report! Not hand written – which will receive a 10% reduction. However, you may **neatly** write your calculations by hand either within the body of the report or as well-labeled attachments, (e.g., "For the calculation of the loop's equation, see Figure 4"). Or if you prefer, you may use Word's equation editor (see me if you need help). Remember to use at least a 12-point font.

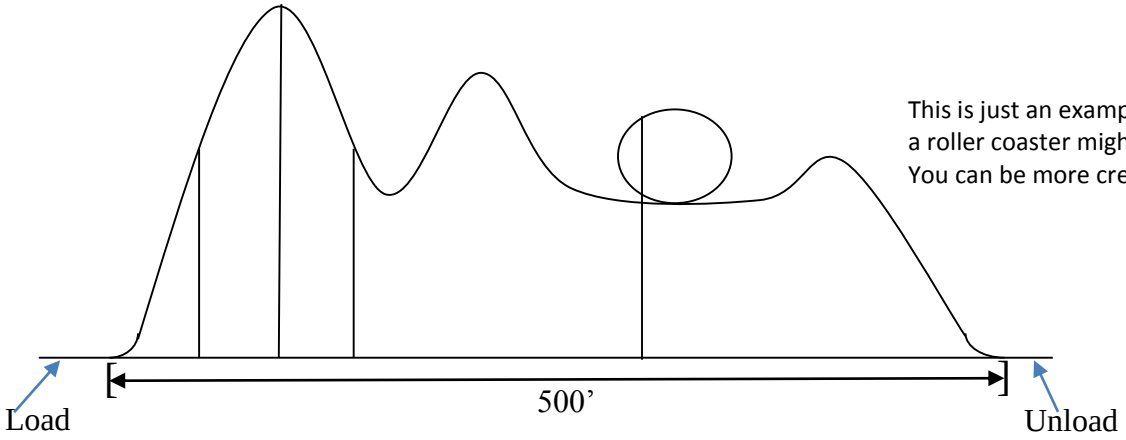
Here's a suggested time-line:

End of Week 7: Have your complete sketch, and the equations for at least the first couple of cubic functions or curves.

End of Week 8: Have your complete design, and all of your equations, with your computer generated graph. Have some of your thrill and support cost calculations done. Have at least an outline of your final report *typed into the computer.*

Week 9: Finish writing, proofread, double check calculations. Compare your report to the scoring rubric -- have you missed anything? Do you need to improve? Are your mathematical explanations correct and complete?

This particular roller coaster has no sideways turns in it. It is just an up and down roller but there are a few features that you **must** take into consideration:



- The coaster must be exactly 500 feet in length along its base, leaving the ground at "zero" feet and touching back on the ground at 500 feet. It must start and end at ground level with a short horizontal section so people can get on and off the car safely-these horizontal sections are in *addition* to the 500 ft., so the count for the 500 ft is the point where the track leaves the ground until the track touches back down.

- Your scale must be one-to-one. Do not "scale down" your roller coaster.

- You will start the coaster using a flat line before the zero mark, then a cubic or other curved function, and then build the rest by splicing together other cubic functions or other curves (parabolas, cubic functions, sine waves, whatever you like!). **Your coaster must have at least one cubic function and 2 other curves in addition to the enclosed loop(s), for a minimum of 3 hills and one loop.**

- The entire ride must be smooth - the function values *and derivative values* must match at every joint. It is easiest to splice two functions together at a minimum or maximum and you are encouraged to do this for most of your splices, but at least one splice must happen at a non-zero slope point.

- You must include at least one loop. It is easiest to place a loop on a horizontal section of track so that it touches the track only once (why??) – anywhere else, the loop must be tangent to the curve (touching at a single point). Try a circle or an ellipse (although neither are used in "real life", they can have deadly consequences). **Its minimum diameter must be at least 30 feet.**

- There is a support every 25 feet, starting the measure from the point where the track leaves the ground, and the cost, in dollars, of the material needed for the support is **the square of the height of EACH support**, measured in feet. Supports for the loop hit the highest appropriate point, as shown above. *The track and cars are free (they're being recycled from a previous project).*

- For the adventurous, any tunnels have a cost as well: the cost in dollars is the sum of triple the maximum depth and double the horizontal distance from the point where the track descends below the ground to where the track re-emerges above ground.

- The tallest hill cannot have a height greater than 150 feet. Since the first climb is the only one that has mechanical help, you must be sure that your coaster can make it over every hill. We will assume that the coaster can make it over no more than 75% of the height of the previous hill. Therefore, the tallest part of the loop can't be over 75% of the height of the previous hill. And, any peaks after a loop can only be at most 75% the height of the loop.

- You must find the angle (in radians) at the steepest point for each **descent** (that is, the angle of depression) after each peak, or drop, not including the loop. This angle is defined to be the "Thrill" of that descent. The "Thrill" for the entire ride is sum of all the descents plus the number of peaks in your ride (including your loop). A loop counts as a peak, but does not have an angle. Recall, the tangent trig function gives the slope of the terminal side of an angle, so if you take the inverse tangent of your slope you will get the angle measure; make sure you're in radian mode!