Holistic Numerical Methods Institute
committed to bringing numerical methods to undergraduates

http://numericalmethods.eng.usf.edu/experiments

Length of curve experiment

Background: The motivation behind the experiment is Runge's numerical experiment to show that higher order interpolation is a bad idea. Read these pages (1, 2) of the book where it is shown that as you use higher order interpolants to approximate $f(x)=1/(1+25x^2)$ in [-1,1], the differences between the original function and the interpolants becomes worse. This concept also becomes the basis why we use splines rather than polynomial interpolation to find smooth paths to travel through several discrete points (Read these pages for further information).

What you will do in the lab: A flexible curve (Figure 1) made of lead-core construction with inch graduations from 0 to 12" is provided to you. You need to draw a curve similar in shape to the Runge's curve on the provided graphing paper as shown. It just needs to be similar in shape – you can make the x-domain shorter and the maximum y-value larger or vice-versa. Just be sure that there is only one value of y for a particular value of x, and that you record the length of the curve. *Please do not draw the same curve as your group partners.*

Exercises to do (Counts as 50 points):
First, follow the sample project guidelines.
Use MATLAB to solve problems (3 thru 6). Use comments, display commands and fprintf statements, sensible variable names and units to explain your work. Staple all the work in the following sequence. **Use USCS system of units throughout.**

1. Signed typed affidavit sheet.
2. Attach the plot you drew in the class. Choose several points (at least nine – do not need to be symmetric) along the curve, including the end points. Write out the co-ordinates on the graphing paper curve (see Figure 1 for example).
3. Find the polynomial interpolant that curve fits the data. Output the coefficients of the polynomial.
4. Find the cubic spline interpolant that curve fits the data. Just show the work in the mfile. No command window output is needed except a disp statement stating what you did in this part.
5. Illustrate and show the individual points, polynomial and cubic spline interpolants on a single plot.
6. Find the length of the two interpolants – the polynomial and the spline interpolant. Calculate the relative difference between the length of each interpolant and the actual length of the flexible curve.
7. In 100-200 words, type out your conclusions using a word processor. Any formulas should be shown using an equation editor. Any sketches need to be drawn using a drawing software such as Word Drawing. Any plots can be imported from MATLAB.
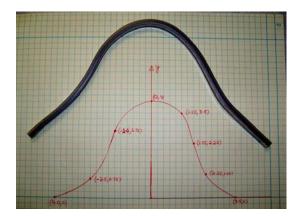
Figure 1. Using a flexible curve to draw a curve of known length. This is only a sample curve. Your curve may look different, have different co-ordinates, and /or have different number of points chosen (errata – the first co-ordinate in the figure is (-4,0)).