**ENED 1091 HW#3**

**Due on Recitation Day Week of February 23rd**

**Problem 1:**  The graph below shows position measurements (in cm) collected every 0.5 seconds over a 10 second interval of time.

1. Using ***linear interpolation***, estimate the position of the object at 2.45 seconds. Do this by hand (no ***interp1***) and show your calculations.

**Calculation and Result (include units): 6.7 cm**

1. Now use ***interp1*** and linear interpolation to estimate the position of the object at 2.1, 2.2, 2.3, and 2.4 seconds.

**MATLAB Command and Results (include units): 4.6000 5.2000 5.8000 6.4000 cm**



**Problem 2:** For this problem, you need the excel file, HW3.xlsx posted on the Blackboard Metasite under Homework Assignments, HW#3. The excel file has a vector of times, t, which starts at 0 increments by 0.001 and ends at 0.015 seconds. It also has a vector of voltage measurements, V, corresponding to the given times. Import both columns into MATLAB using the import tool or the xlsread command.

1. Use ***interp1*** with a method of ***nearest*** to estimate the voltage every 0.0001 seconds between 0 and 0.015 seconds. On the same plot (not subplot), plot the original data points as red stars and the interpolated data points as black circles.

**MATLAB Commands and Plot**

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1. Use ***interp1*** with a method of ***linear*** to estimate the voltage every 0.0001 seconds between 0 and 0.015 seconds. On the same plot (not subplot), plot the original data points as red stars and the interpolated data points as black circles.

**MATLAB Commands and Plot**

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1. Use ***interp1*** with a method of ***spline*** to estimate the voltage every 0.0001 seconds between 0 and 0.015 seconds. On the same plot (not subplot), plot the original data points as red stars and the interpolated data points as black circles.

**MATLAB Commands and Plot**

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1. What kind of waveform does your plot in part (c) look like? Could you possibly have picked this up from looking at the original data points?

**Waveform looks like a sine wave. Would have been somewhat difficult to pick up from original data points.**

**Problem 3:** The graph below shows position measurements (in cm) collected every 0.5 seconds over a 10 second interval of time.



1. Using a Δt = 0.5 sec, estimate the velocity at t =  sec using the 2-point estimate and the 3-point estimate for the derivative. **Be sure to show your work and include units!**

2-point Estimate of Velocity at t = 2.5 sec: **6 cm/s**

3-point Estimate of Velocity at t = 2.5 sec: **6 cm/s**

1. Using the estimate for 2nd derivative and a Δt = 0.5 sec, estimate the acceleration at t = 2.5 sec. **Again, show work and include units!**

Estimate of Acceleration at t = 2.5 sec: **0 cm/s2**

1. What could be changed to improve the accuracy of the derivative estimates?

**Taking measurements more often (smaller time interval) will generally improve the accuracy of the derivative estimates.**

**Problem 4:** An exponentially decaying sinusoid can be used as a mathematical models for several applications including damped harmonic motion, damped vibrations in structures, and filters. The general form for an exponentially decaying sinusoid is:



Suppose we have a mass connected to a spring. The spring is compressed 1 cm then released. Based on the characteristics of the mass and spring, we determine that the displacement of the mass from equilibrium (in cm) is:



We would like to determine how often we will need to take measurements of the displacement in order to be able to get a good estimate for the velocity of the mass.

Write a script file that will do the following:

* Prompt the user for a DeltaT value
* Create a time vector ranging from 0 to 15 seconds with an increment of DeltaT.
* Calculate the displacement “measurements” at the corresponding times in the time vector.
* Create a second time vector ranging from 0 to 15 seconds with an increment of 0.001.
* Calculate “actual” displacement using this second time vector.
* Use the subplot command to subdivide the figure window into a top and bottom plot.
* On the top plot, plot both “actual” displacement and displacement “measurements”.
* Using the displacement “measurements” and DeltaT, estimate the velocity using the 2-PT estimate.
* Calculate the “actual” velocity from 0 to 15 seconds using the finer time increment of 0.001.
* In the bottom plot, plot “actual” velocity and the 2PT estimate of velocity.
* Add title, labels (with units), and a legend to each of your plots.

Run the script using a DeltaT = 1. Paste the plot below.

**PLOT for DeltaT = 1**



Run the script using a DeltaT = 0.5. Paste the plot below.

**PLOT for DeltaT = 0.5**



Now determine a DeltaT value that will produce accurate estimates for velocity ***keeping in mind that smaller DeltaT values mean more measurements must be taken and computations must be completed in a shorter time frame.*** In the space below indicate your choice of DeltaT and also paste the corresponding plot.

**PLOT for DeltaT = \_\_\_\_\_\_\_\_\_\_\_\_\_**

**PASTE SCRIPT HERE:**