CALIFORNIA INSTITUTE OF TECHNOLOGY
Department of Mechanical Engineering

ME 96
Beam Experiment — Problem Set #2

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Optional reading:

- Signals and systems: BML, Chapter 4, pp. 127–161

Lab assignment:

1. Using the computerized data acquisition system, take measurements of the dynamic response of the beam (both axes) at a variety of sample rates. Choose at least one sample rate which is less than twice the frequency of oscillation (so that you can see the effects of aliasing).
2. (Optional) Attach a strain gauge to a section of beam. When the gauge is firmly attached (24 hours), attach leads to the gauge and verify that the electrical connections are OK. You should be prepared to make use of this beam during the third lab session.

Problems:

1. Sketch the experimental setup for the cantilevered beam experiment in 0018 Thomas. Include all of the components which are relevant to the measurements which you are taking. Give a short description of each component, including an estimate of its bandwidth (from the manuals or standard references). Make sure to include the resolution and maximum sample rate of the data acquisition card.
2. Include a photocopy of of the section of your lab book showing the different trials that you ran and the names of the files in which the resulting data is stored. All of your plots in this homework set should be labeled with the name of the datafile containing the raw data.
3. Write a program to determine the period of oscillation and damping constant for a time series of periodic data. Your program should compute the period and damping ratio for each cycle in your data. Test your program on a series of test data with a known frequency and damping constant. Include a listing of the source code for your program with sufficient comments to interpret your algorithm.
4. Use your program to determine the fundamental frequency and damping constant for the data that you took in the lab.
   - For each data set, compute the average period and average damping constant over all cycles.

- For a single set of data in each axis, plot the fundamental frequency and damping ratio as a function of the size of the oscillation. (Make sure to clearly define how you compute the "size".)
- For a single axis, plot the fundamental frequency and damping ratio as a function of the sample rate. You should plot multiple points at each sample rate to indicate the spread of the data. Comment on any unusual features. You should notice aliasing on the appropriate data set.

5. Use an FFT to determine the frequency of oscillation for your data sets.

   - For all data sets, compute the frequency of oscillation and compare it to the values you computed in Problem 2.
   - For at least one data set, plot the fundamental frequency as a function of the window size. You should vary the window size from approximately one oscillation to the size of the entire data set. Use your best judgement about how many points to compute in between. Explain your results.
   - Pick a fixed window size and plot the frequency of oscillation as a function of the window starting location. Explain your results.