LAB #1 / Homework #1

Problem #1

a) *Statistics*: Download the file "Data_1" from **eclass** webpage. Using the functions AVERAGE(range) and STDEV(range) in Excel, calculate mean, standard deviation and coefficient of variation for this data set. Then using the **Histogram** function in the **Analysis Toolpak**, create a histogram of the results using 200 psi intervals (bin). Provide a table of the data and statistical results as well as a histogram using Excel. (see handout for review on statistics)

b) *Graphing*: Download the file "Data_2" from my webpage (it contains stress vs strain data). Plot this data using Excel and the Chart Wizard (use the option of X-Y plots) with the appropriate axis labels and a title, with stress shown on the Y axis. You will notice an offset in the strain due to improper initial seating of the apparatus. Correct the offset by subtracting an appropriate value from the raw strain values and generate a corrected plot. Please use this opportunity to familiarize yourself with the various editing capabilities of Excel charts, including resizing, axis and title labeling, selection of colors and other Excel functions.

Problem #2

The file "ELCENTRO.xls", which can be downloaded from my web site, contains time acceleration history data from the historic earthquake that hit ElCentro in 1940. This earthquake was the first one ever to be recorded using a strong motion accelerometer. Figure 1 summarizes a simple numerical integration scheme (trapezoidal rule).

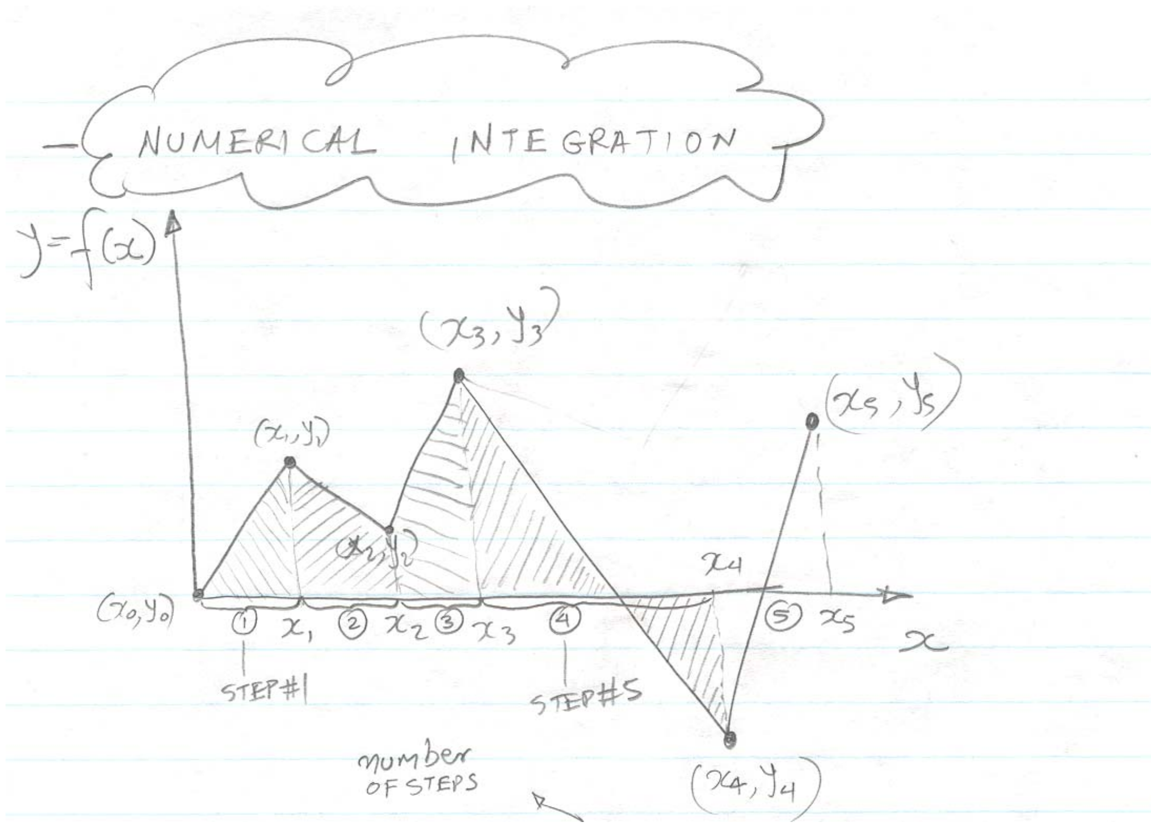
a) Integrate the acceleration series a(t) to obtain velocity v(t). Using excel function LINEST obtain the line that best fits your data. Correct your velocity series using the following equation: $v_{correct}(t)=v(t)-(m*t+b)$
   Where, m, b constants returned by LINEST.
b) Integrate the velocity history $v_{correct}(t)$ to obtain displacement d(t). Correct the displacement series applying the same procedure as above.
c) Graph $v_{correct}$ (t) versus time and $d_{correct}$ (t) versus time.

Assignment #1

Visit the Library and locate books on experimentation of structures or experimental mechanics. In those books you can find definitions and examples of the following terms related to the performance of measuring systems:

a) Sensitivity,
b) Accuracy, and
c) Precision.

Please provide a definition and an example of each one of the aforementioned terms. In addition, find information on the different types of errors encountered by experimentalists (scientists and engineers) and provide a brief description of those also.



$$I = \int_0^x f(x)dx \quad \cong \sum_{i=1}^{n} \frac{y_i + y_{i-1}}{2}(x_i - x_{i-1})$$

Figure 1 A numerical integration scheme, trapezoidal rule.

Review of Descriptive Statistics

During this semester you will be completing a number of experiments that attempt to describe mechanical properties of an engineering material. It is insufficient to complete only one test of a material. If we test only one sample of a material for its strength, and then base our engineering designs on this one test, we are ignoring the fact that this one specimen might have been incredibly strong or terribly weak as compared to the all of the other pieces of material that we might have chosen.

For this reason, whenever possible, we test a large number of specimens, all substantially the same. If we test a large number of specimens then we will see that some coupons (or samples) are stronger than others. The average or mean of all of the tests is the "**expected value**" or most likely to be the real strength of the batch of specimens. By testing a large number of specimens, we also reduce the change that experimental errors will warp our measurement of the given material property. Note that if a set of samples is denoted as x, then the mean is denoted $\bar{x}$.

We are all familiar with the term mean. The second important descriptive statistic is the standard deviation. The standard deviation is a measure of the spread of a given set of tests. For example, wood is a relatively variable material because it contains many inherent flaws-checks, knots, splits, etc. We would therefore expect a high standard deviation when we test a material like wood. On the other hand, steel is manufactured through a process that is strictly monitored and quality controlled. We can therefore expect that the standard deviation for steel is lower than that of wood. Note that as the standard deviation increases, the fatness of the normal distribution or bell curve increases.

The standard deviation, s, for a sample set is calculated as:

$$s = \sqrt{\frac{n\sum x^2 - \left(\sum x\right)^2}{n(n-1)}}$$

here, *s* is the sample standard deviation, n is the number of samples in the set and the x represent the set of sample readings.

Note that as the mean of any set of readings increase, the standard deviation also increases. It is often useful to describe a set of statistics by the relative standard deviation (often called the coefficient of variation), which is simply calculated as $s/\bar{x}$. Expected **<u>coefficients of variation</u>** (COV) range between 3% for materials that are quite uniform and have been tested with extreme precision, up to 20% for materials that are quite variable and/or can only be tested using imprecise test methods.