Homework 1

(Due Date: Monday, Feb. 02)

In this homework you will practice how to calculate the mean, variance and apply error propagation seen in the first class (see website the slides for lecture 1.)

Problem 1:
Consider a cart rolling down a slope. If you measure the velocity of the cart at two points separated by a distance "*d*", you can estimate the acceleration "*a*" of the cart using the constant-acceleration formula:

$$v_2^2=v_1^2+2ad$$

If a student performs the measurements of the velocities and distance 12 times with results:

d	197.7	197.7	197.7	197.7	197.7	197.7	197.7	197.7	197.7	197.7	197.7	197.7
V_1	186	184.3	185.8	186.8	181.9	185.2	184	185.7	186	185.5	182.5	183.8
V_2	323.5	320.6	323.2	324.8	316.4	322.1	320	322.9	323.5	322.6	317.4	319.6

(a) Calculate the average and the standard deviation for each of the measured quantities.

(b) Calculate the acceleration "*a*".

(c) Calculate the different contributions to the error in *a,* and calculate the total error of *a* using error propagation of a multivariable function.

Problem 2: A student measures the voltage drop across a resistor of as a function of applied current to the resistor. She/he takes six runs of data shown in the table below.

Current	**Run 1**	**Run 2**	**Run 3**	**Run 4**	**Run 5**	**Run6**	**Average**	**St. Dev.**
I (mA)	**V1**	**V2**	**V3**	**V4**	**V5**	**V6**	**Vave**	**σ_v**
1	5.03	3.58	2.67	2.72	2.63	3.42		
2	7.31	7.31	9.39	9.39	8.84	7.27		
4	12.78	11.80	11.57	11.38	10.85	12.15		
6	13.33	14.95	15.27	12.69	16.78	15.58		
8	16.55	17.77	16.64	16.52	17.69	19.44		
10	20.03	21.26	20.75	20.92	21.57	20.17		

(a) For the data runs obtain the average voltage as a function of applied current, and the standard deviation of the voltage for each value of applied current. Show the equations for the calculation.

(b) Using Matlab, plot the voltage as a function of current for the 6 runs in the same figure.

(c) In a second figure plot the average voltage (**Vave**) as a function of current and show for each point its standard deviation (σ_v) with an error bar (use "errorbar" function in Matlab.)

Note: Include axes with labels for the figures. Also include a legend identifying each run for Fig. 1 and a legend identifying **Vave** and σ_v in Fig.2.

(d) Assume that the current has a relative error (σ_I/I)$=1x10^{-3}$ so that $\sigma_I = I*1x10^{-3}$ in every run. Using the values of the voltage (**Vave** and σ_v) and the current (I and σ_I) for each row with a constant current value, estimate the resistance **R** and its error σ_v for every row (to determine the error you need to use error propagation.)

3.- Review:

- Review the required parts for the formal lab report and the guidelines: Formal Report Guidelines
- Review the required parts for the lab notebook and the guidelines: Lab notebook Guidelines