Phys5053 - Assignment 3 **Due Wed, 13 Oct**

1. A student hangs different weights on a spring and measures the spring's extension as a function of the applied force. Her goal is to find the spring constant *k.* Her measurements of mass *M* and extension *L* are:

M (g):	200	300	400	500	600	700	800	900
L (cm):	5.1	5.5	5.9	6.8	7.4	7.5	8.6	9.4

There is an uncertainty of 0.2 cm in each measurement of the extension. The uncertainty in the masses is negligible. For a perfect spring, the extension ΔL is related to the applied force as $k\Delta L=F$, where $F=mg$, and $\Delta L=L-L_0$, and L_0 is the length of the un-stretched spring. Find the spring constant *k*, the unstretched length L_0, and their uncertainties. Find χ^2 for the fit and the associated probability. Plot the data with error bars, the line of the best fit, and the lines corresponding to the most extreme (in terms of the slope and intercept) possible fits.

Depending on your approach, you may find it useful to use cftool or, alternatively and more generally, the function 'fit'. For example,

```
[cfun gof]=fit(x,y,'poly1')
```

performs a linear fit (poly1 stands for polynomial of first degree) and returns a number of fit statistics.

2. Perform this sequence of commands:

```
A=lognrnd(1,0.5,1000,1)
X=0:0.5:10
B=1000*lognpdf(X,1,0.5)
```

The variables A and B now contain two different representations of *the same* distribution (log-normal): the variable A contains a set of "measurements" drawn from the log-normal distribution, and B contains the y-values of the histogram, i.e. the description of the parent p.d.f. Perform the following actions for *each* of the representations (A and B) and compare the results in a table.

a) Plot A and B on the same graph to visualize how similar they are.
b) Calculate the mean, variance, and standard deviation.
c) Calculate the error on the mean. State the minimum and maximum values of the interval that is expected to contain the "true" mean with 80% confidence. What was the number of the degrees of freedom that you used?

Did you have to use any methods that rely on the data being distributed normally? If yes, check if this has affected your results.

Verify your results by comparing them to the true mean and variance, which can be obtained by running the function 'lognstat'.

3. A sound source of frequency f is moving with velocity v toward a fixed observer. The change in frequency produced by the Doppler shift is given by $\Delta f = f\,v\,/\,(u - v)$

where u is the velocity of sound. From the following values of u, f, and v and their uncertainties, calculate Δf and its uncertainty. Which, if any, of the given uncertainties make a negligible contribution to the uncertainty in Δf?

u = (332+-8) m/s; f=(1000+-1) Hz; v=(0.123+-0.003) m/s.