The University of Edinburgh
School of Engineering and Electronics

2nd year MechEng laboratory

Plotting Graphs

1. Some Important DOs and DON'Ts

A graph should convey the necessary information with as much clarity as possible, and with minimum potential for confusion - the following are guidelines to this end. Don't be daunted - rules for good graph plotting are mostly common sense.

Do plot the graph the right way round - *y against x* means *y* on the vertical axis and *x* on the horizontal axis.

Do plot to a true zero. This rule may sometimes be relaxed where *x* is concerned. Discuss other possible exceptions with a demonstrator.

Do choose scales which are easy to plot and read from. Stick to multiples of 2, 5 or 10 small squares.

Do mark the errors bars (often only necessary on *y*)

Do label the axes with *"label in words, symbol (units)"*.

Do give the graph a title and a figure number (*eg* fig.1) where appropriate. In reports, this applies to all pictorial material including photographs and sketches - give everything a figure number in order of appearance. Try to keep the actual figures in the same order as they are referred to in the text.

Do mark experimental points clearly with crosses, using circles, squares and triangles if you need to plot more data sets on the same graph.

Do represent theoretical predictions by continuous curves. These may be full or broken lines, but they should *not* show specific calculations as "points" - these could be confused with experimental values.

Don't join up your experimental points with a zig-zag line. Most engineering functions vary smoothly. If the graph oscillates with an amplitude greater than the error bars, then you should check your estimates of the error.

Don't necessarily use the whole page for a graph. It is seldom necessary for accuracy, wastes space and can look untidy.

Don't plot to scales which are more accurate than your error estimates justify.

2. Some Hints on the Use of Graphs to Analyse Experimental Results

In the classic experiment, all parameters except two are fixed. Of these two variables, one is under your direct control - the *independent variable, x* - while the other, the *dependent variable, y,* changes as a result of a change in the independent variable.

In a particular experiment, a jet of water strikes a metal vane. You measure the velocity (v) of the jet and the resulting force (F) on the vane. The velocity is varied in a series of steps and a value of the resulting force measured for each step. At the end of the experiment, you have the data set (v, F). If you don't know the theoretical relationship between F and v, then you will want to find its functional form. The following hints will help.

1. If the result of an experiment is the data set (x, y), the easiest way of "seeing" a relationship between the continuous variables x and y is to plot a graph of y against x using linear scales.
2. Check your plotted points. Are they bunched too close together? Are they spread out too far apart? If unsatisfactory, change your scale(s) and replot.
3. Attempt to "fit" the points by drawing a continuous line through them. Do not try to join up all the points - due to experimental error, they will scattered randomly about a line of best fit.
4. Is the "best fit" a straight line? If so, you should represent it by the equation $y = mx + c$ and obtain values (± experimental error) for the constants m and c.
5. If the "best fit" is not a straight line, then you can try plotting your data on various non-linear scales, but first try to deduce from the theory a plausible form of the relationship between y and x.
6. If you think your relationship is a specific power law, *eg* $y = Ax^2$, then plot y against x^2. Of course, this will work with other functional forms too.
7. If you think the relationship is a more complex power law, then try plotting log y against log x. If you are correct, you will be able to work out the form of the power law. If you haven't met this before, discuss it with your colleagues. If stuck, discuss it with a demonstrator.
8. If you think the relationship is exponential, *eg* all linear decay processes, then plot log y against x.

To save you working out all the logarithms, you can use graph paper with logarithmic scales. Such specialist graph papers include *log - log* (number of cycles on each scale depends upon the range of the variables), *log - linear* and *polar*.