Assignment 1.

Using Spreadsheet SDOF2005 to study dynamic motion

Objective
To enable the student to better understand the implications of applied boundary conditions, namely when initial displacement or initial velocity is not zero, on damped forced SDOF motion.

Materials and Methods
The student is given an Excel spreadsheet (SDOF2005.xls). This spreadsheet has on it the formulation for the general solution to SDOF forced, damped motion. The user can specify any initial condition, ie, Initial displacement = something as well as initial velocity equals something. The student can also specify the driving frequency and amplitude as well.

Input values and their explanations are listed on the spreadsheet. Some intermediate computed values are also shown, such as natural frequency and phase angle. The computation of time and displacement are listed in two columns to the right of the inputs. The user can continue the time column as long as desired. To determine the displacement, simply copy and paste a formula from the displacement column to additional rows next to the time column. Note that the calculation of displacement is large and not easily programmed if lost.

If one wishes to compare two sets of data simply copy the first set of data (time, displ) and paste special (values) so as not to carry the formulas, but only the results. The data can then be recomputed in the original columns and all four columns plotted for comparison.

Discussion
The student should play a little with the spreadsheet by first setting the driving amplitude to zero. This is equivalent to having a freely oscillating system. A little damping, say 0.05 will slow down the oscillations nicely. Some initial X or initial V is required at this time since that is the only boundary condition involved. You have to swing the pendulum in order for it to move.

The second level of investigation is to set initial X,V to zero and play with the driving force and frequency. Again, some damping, say 0.05 would be good. Note that the closer the driving frequency is to the natural frequency, the higher the displacement amplitudes. How long does it take to reach a steady-state oscillation?

What about higher (or lower) damping?

What about changing mass?
Finally one can impose some initial $X$ (or $V$ or both) as well as a driving force and witness the transient and steady-state portions of the response. Note that the damping plays a critical role in how long the system requires to reach a steady-state condition.