MATH333: Tutorial 4 (3-3-00)

1 Saving in MATLAB

To save a figure in the MATLAB environment, we can use

$$>> print\, figure1.ps$$

2 Double Precision

In order to increase the accuracy of the solution, we sometimes use double precision to represent a real number. In FORTRAN, a double precision real number can be declare by using the type:

DOUBLE PRECISION

or simply

REAL*8

3 Numerical Recipe in FORTRAN

But note that most of the subroutines and functions are written in single precision, REAL. Therefore, all the input argument in these subroutines should be in single precision. However, if you really want to use REAL*8 instead, what you have to do is to copy the subroutine, or function, to your program from the directory

$$/usr/local/share/lib/numrec-2.04/f77/recipes/$$

And then change the variable type from REAL to REAL*8.

4 Exercise

1. Consider the undamped and unforced pendulum, governed by the equation

$$\frac{d^2\theta}{dt^2} + \omega^2 \sin\theta = 0\,.$$

The period of the motion can be obtained analytically as

$$T = \frac{4}{\omega}\int_0^{\pi/2} \frac{d\phi}{(1-a^2\sin^2\phi)^{1/2}}\,, \tag{1}$$

with $a = \sin(\theta_m/2)$.

Calculate the integral numerically and compare the solution to the approximated ones:

$$T = \frac{2\pi}{\omega}\left(1+\frac{\theta_m^2}{16}\right), \text{ for small } \theta_m. \tag{2}$$

$$T = \frac{-4}{\omega}\ln\left(1-\frac{\theta_m}{\pi}\right), \text{ for } \theta_m \simeq \pi. \tag{3}$$

2. Using the same parameters you obtained in the previous exercise Q 3.3, plot the motion of the pendulums in the phase diagram, i.e. $\dot{\theta}$ vs. θ.

3. (Bonus) Obtain the "Basin Of Attraction" for a damped, but undriven, pendulum.

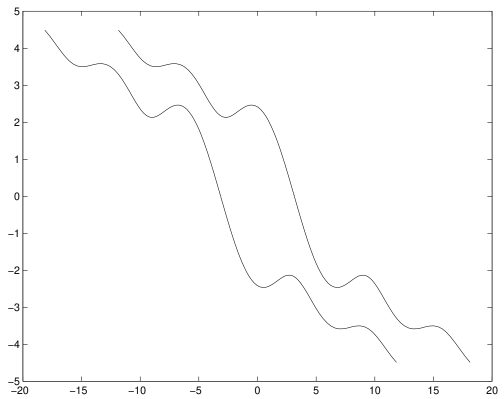

Figure 1: Basin of attraction of a damped and unforced pendulum.