PHYS 105: Introduction to Computational Physics

Spring 2016

Homework #2

(Due: April 21, 2016)

1. Find numerically *all* maxima, minima, and zeros of the Bessel functions $J_0(x)$, $J_1(x)$, and $J_2(x)$ in the range $0 \le x \le 30$. Grid the functions with an interval $dx = 0.1$, and remember to use linear interpolation to refine your estimates of the zeros. As discussed in class, the Bessel functions are accessible in C++ as `j0(x)`, `j1(x)`, and `j2(x)`, and in Python as `jn(0,x)`, `jn(1,x)`, and `jn(2,x)`.

2. In-class Exercise 3.3.

3. A particle moves under a simple-harmonic force law

$$F(x) = -5x.$$

   starting at $x = 0$. Due to the competing effect of friction, the particle's motion is actually given by

$$x(t) = e^{-t} \sin 2t.$$

   Modify the trapezoid integration scheme discussed in class to compute the work done by the force F on the particle as it moves, i.e. compute the running integral

$$W(t) = \int_0^{x(t)} F(x)\, dx$$

   by breaking it into steps of length $dt = 0.1$ and summing the contributions

$$dW = \tfrac{1}{2}[F(x_i) + F(x_{i+1})]\,(x_{i+1} - x_i),$$

   where $x_i = x(t_i)$. Plot W as a function of t for $0 \le t \le 10$.

In addition to your answers to specific questions, turn in hardcopy of your programs and any non-graphical output produced when they run, as well as all requested plots, *with axes clearly labeled.*