PHYS 3340
Spring 2008
TE Coan
Due: 26 Mar '08, 6pm via email.

Homework 6

1. Code the iterative affine transformations in *CP* (p. 300) to produce the fractal tree described in our text. "Grow" the tree at $(x_0, y_0) = (0.5, 0.0)$. Include a plot of the tree in your answer file and use at least $50,000$ iterations to produce your tree. (Yes, I realize we did this in class.) Attach code and plot in your answer file.

2. Machine find a root to the following functions $f(x)$ with the associated initial guesses. Also, create a plot that shows x_i versus iteration i.

$$\begin{array}{ll} f(x) = \tanh(x) & x_0 = 2.0 \\ f(x) = \ln(x) & x_0 = 3.0 \\ f(x) = \sqrt{(x^2 + 2x + 1)} - 2x\sin(x) & x_0 = -5.0 \end{array}$$

Indicate what the tolerance is for your roots and attach the plots to your answer file.

3. The Newton-Raphson (NR) technique can take a long time or even diverge for functions that have a complicated analytic behavior near a root. For example, compare the number of iterations required by the NR technique to find the root near $x = 0$ with an accuracy of 10^{-4} for the functions $\sin(x)$ and $x\sqrt{|x|}$ when starting from $x = 0.1$. Perform the same comparison using the bisection technique. Include relevant data in your answer file.

4. Find the energy eigenvalue associated with each of two bound states for the potential well discussed in lecture. This means you need to solve the equation $f(\xi) = \xi \tan\xi - \eta = 0$, where

$$\xi^2 + \eta^2 = \frac{2mV_0a^2}{\hbar^2} = 16.08$$

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You will also need $\xi = \alpha a$ and $\eta = \beta a$, as well as $\beta = \sqrt{-2mE/\hbar^2} = \sqrt{-0.483E}$ and $\alpha = \sqrt{2m(E + V_0)/\hbar^2} = \sqrt{0.483(E + V_0)}$. As a reminder, energies E are measured in MeV and distances x are measured in fm. (Recall that $V_0 = 83\,\text{MeV}$ and $a = 2\,\text{fm}$.) Include code and eigenvalues in your answer file.