PHYS 307: Computational Physics Lab (QM)

Winter 2012

Homework #2

(Due: January 30, 2012)

1. In class we studied the finite potential well problem—that is, the solution to Schrödinger's equation with potential

$$V(x) = \begin{cases} 0 & (|x| < a)\,, \\ V_0 & (|x| > a)\,. \end{cases}$$

Analytical solution entails solving the equations

$$\xi \tan \xi = \eta$$

or

$$-\xi \cot \xi = \eta$$

subject to the condition

$$\xi^2 + \eta^2 = \frac{2mV_0a^2}{\hbar^2} \equiv U_0\,,$$

where m is the mass of the particle, $\xi^2 = 2mEa^2/\hbar^2$, and $\eta^2 = 2m(V_0 - E)a^2/\hbar^2$. The energy E lies in the range $0 < E < V_0$. The "tan" and "cot" equations correspond, respectively, to even and odd solutions for the wavefunction.

Modify the programs discussed in class to solve these equations using the bisection/false-position technique, making sure that *all* solutions are found. Then, by looping over U_0, plot your solutions for scaled energy ξ^2 as functions of scaled potential U_0, for $U_0 = 0, \ldots, 100$ in steps of 0.1. Turn in your final program, as well as a graph of $\xi^2(U_0)$ for $0 \le U_0 \le 100$.