Laboratory-3 (Roots in a Quantum mechanics problem)

September 2, 2020

1. **Bound state energies of a potential well :**

   Given a finite, square, potential well with $V = 0$ between $x = -a/2$ and $x = +a/2$, and equal to V_0 everywhere else.

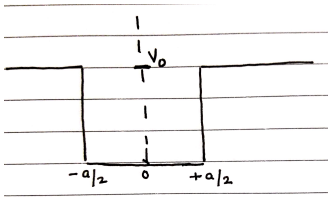

Figure 1:

The bound state energies are discrete. The wavefunctions can be even or odd functions. Here we will find the bound state energies of a particle in this well. Later during the semester we will find the wavefunctions.

Bound state energies are given by the roots of

$$f(\alpha) = \alpha tan(\alpha a) - \beta \tag{1}$$

for even wave functions &

$$g(\alpha) = \alpha cot(\alpha a) - \beta \tag{2}$$

for odd wavefunctions, where $\alpha = \sqrt{2mE/\hbar^2}$ & $\beta = \sqrt{2m(V_0 - E)/\hbar^2}$. m is the mass, a is the length of the potential well. The values of energy E have to be found by finding roots of above equations.

Take $a = 0.3nm$, $V_0 = 10eV$.

Use your root finding codes (already written)[1] to :

(a) Find the ground state energy in the above potential well upto *5 significant figures.* Express these bound state energies in electron volts.

(b) Find the energies of all the other excited states upto *5 significant figures.*

(c) How many bound states exist

Upload your results & the code in the Forum on Quanta. Also take a look at the results of others in the same forum.

[1] If you have implemented root finding algorithm as a MATLAB function to which you pass f(x) as a function handle you should not require to change a single line of your code.