Tutorial-3 [PHN-624]

Q1: The second order schrodinger equation $\frac{d^2\psi}{dx^2} = \frac{2m}{\hbar^2}[V-E]\psi$ can be written in the form of two coupled first order equations

$$f_1 = \frac{d\psi}{dx}, \tag{1}$$

and

$$f_2 = \frac{df_1}{dx} = \frac{2m}{\hbar^2}[V-E]\psi. \tag{2}$$

Using the above two equations, evaluate the eigen states of the finite square-well potential numerically, given by-

$$V(x) = \begin{cases} V_0 & x \leq -10fm \\ 0 & -10fm < x < 10fm \\ V_0 & x \geq 10fm \end{cases} \tag{3}$$

where, $V_0 = 25$ MeV. [**Hint:** Take $m = 938.272$ MeV/c^2; $\hbar = 197.3269631$ MeV-fm.]

Q2: Evaluate the eigen states of the infinite square-well potential numerically, which is given by-

$$V(x) = \begin{cases} \infty & x \leq -10fm, x \geq 10fm \\ 0 & -10fm < x < 10fm. \end{cases} \tag{4}$$

Q3: Evaluate the eigen states of the harmonic oscillator potential numerically, which is given by-

$$V(x) = \frac{1}{2}mw^2x^2. \tag{5}$$

[**Hint:** Choose a larger limit of x for convergence.]
Q4: Evaluate the eigen states of the Wood-Saxon potential numerically, which is given by-

$$V(x) = \frac{V_0}{1 + exp(x-R)/a}, \tag{6}$$

where, depth potential $V_0 = -25.0$ MeV, surface diffuseness $a = 0.5$ fm, and radius $R = 5$ fm. For plotting, take the range (in fm) $-15 < x < 15$.