Birzeit University
Department of Physics
Quantum Mechanics I, Phys433
Fall 2021
Homework 2: Due date Oct. 11th 2021

1. Consider a particle of mass m in the following potential:

$$V(x) = \begin{cases} V_0 & \text{if } 0 < x < L \\ \infty & \text{elsewhere} \end{cases}$$

   (a) What are the wavefunctions of the particle
   (b) What are the energies associated with each wavefunction
   (c) Perfrom fourier transformation on the stationary state solution, that is to transform the wave-functions from the position space to the momentum space. Check the normalization of the transformation.
   (d) Calculate the expectation value of position and linear momentum in both position space and momentum space.

2. A particle of mass m is placed in an infinite square well in the region 0 < x < a. At t = 0 its normalized wave-function is:

$$\Psi(x, t = 0) = A[1 + cos^2(\frac{\pi x}{a})]sin(\frac{\pi x}{a})$$

   (a) What is the wave function at a later time t
   (b) What is the average energy of the system at t = 0 and at later time t
   (c) Calculate σ_x,σ_p
   (d) If the energy was measured, what is the probability of obtaining a result greater than $\frac{\pi^2\hbar^2}{2ma^2}$

3. An electron is moving freely inside a one-dimensional infinite potential box with walls at x = 0 and x = a. If the electron is initially in the ground state (n = 1) of the box and if we suddenly quadruple the size of the box (i.e., the right-hand side wall is moved instantaneously from x = a to x = 6a), calculate the probability of finding the electron in

   (a) the ground state of the new box
   (b) the first excited state of the new box.
   (c) What is the expectation value of the energy