Assignment - 7

Course: PHYS 304 - Introduction to Quantum Mechanics Instructor: Dr. Ke Zou

Problem 1

Griffiths 3.30. Derive the transformation from the position-space wave function to the "energy-space" wave function $c_n(t)$ using the technique of Example 3.9. Assume that the energy spectrum is discrete, and the potential is time-independent.

Problem 2

Griffiths 3.45. Find the position operator in the basis of simple harmonic oscillator energy states. That is, express

$$\langle n|\hat{x}|S(t)\rangle \tag{1}$$

in terms of $c_n(t) = \langle n|S(t)\rangle$. Hint: Use Equation 3.114

Problem 3

Evaluate the expectation value of the position operator $\langle S(t)|x|S(t)\rangle$ for some state, $|S(t)\rangle$, using the momentum basis (i.e. assume you only know what are the expansion coefficients (i.e. the wavefunction in the momentum basis,$\Psi_S(p,t)$ of $|S(t)\rangle$ in the momentum operator's eigen state basis). Note that this requires you to find the matrix representation of the position operator $\hat{x}$, in the momentum basis.

Problem 4

Griffiths 3.20 Test the energy-time uncertainty principle for the wave function in Problem 2.5 and the observable x, by calculating σ_H, σ_x and $d < x > /dt$ exactly.