

Worksheet #8

(Friday, January 23, 2026)

Name

Questions (5 pts):

A quantum harmonic oscillator is in a state described by the following wavefunction: $|\Psi(t)\rangle = 1/\sqrt{2} (|0\rangle + e^{-i2\omega t} |2\rangle)$, where $|n\rangle$ are eigenstates of the Hamiltonian.

- (a) What is the expectation value of the position operator X in this state?

$$\langle \Psi(t) | X | \Psi(t) \rangle =$$

- (b) Generalize your observation to an arbitrary state

$|\Psi(t)\rangle = \text{norm. factor} * (c_n e^{-in\omega t} |n\rangle + c_m e^{-im\omega t} |m\rangle)$. Under what conditions is $\langle X \rangle(t) \neq 0$?