

Physics 4410 - Quantum Mechanics II – Fall 2004
Problem Set 9

Due November 3, 2004 at 11:00 AM in Duane G2B21

Reading assignment: Shankar Chapter 17; Liboff Chapter 13.

1. Shankar 17.2.2
2. Shankar 17.2.3
3. Shankar 17.3.2
4. Shankar 17.3.3
5. (*20 points*) Consider a two-dimensional Harmonic oscillator:

$$\hat{H} = \frac{1}{2m}(\hat{p}_x^2 + \hat{p}_y^2) + \frac{1}{2}m\omega^2(\hat{x}^2 + \hat{y}^2)$$

Generalize the standard energy-basis treatment of the harmonic oscillator to two dimensions by defining appropriate creation and annihilation operators acting on the (nondegenerate) ground state. Calculate the energy shifts due to the perturbation $\hat{H}' = 2\lambda\hat{x}\hat{y}$ to first order, in the ground state and the degenerate first excited states. Hints: Consider the symmetry of the Hamiltonian, and consider carefully what commutes with what.

6. Solve the previous problem exactly and compare with the perturbation theory calculation.