

**PHYS 452: Quantum Mechanics II (Spring 2015)**  
**Homework #3, due Thursday February 12, in class**

1. Problem 6.8 in Griffiths.
2. Consider the first excited state of the quantum harmonic oscillator in 2D that has the following unperturbed Hamiltonian

$$H^0 = -\frac{p_x^2 + p_y^2}{2m} + \frac{m\omega^2(x^2 + y^2)}{2}.$$

The system is now subjected to a small perturbation in the form  $V'(x, y) = \alpha xy$ , where  $\alpha$  is a constant. Find the first order correction to the energy and proper zeroth order wave functions. Compare to the exact solution.

3. Consider a 3-state system governed by the following Hamiltonian

$$H = b \begin{pmatrix} 1 + \lambda & \lambda & 0 \\ \lambda & 3 - \lambda & \sqrt{2}\lambda \\ 0 & \sqrt{2}\lambda & 3 \end{pmatrix},$$

where  $b$  is a constant and  $\lambda$  is a small parameter, i.e.  $\lambda \ll 1$ .

- (a) Determine the eigenvalues and the corresponding eigenvectors for the unperturbed Hamiltonian ( $\lambda = 0$ ).
- (b) Calculate in perturbation theory the first and second order correction to the energies of all three states.