

## Physics 622

### **Problem set 2** (due February 5)

Sakurai and Napolitano problems (each problem is 10 points):

5.1, 5.3, 5.11(a,b)

**A1. Second order perturbation theory correction to the eigenstate:** Derive the second order correction  $|n^{(2)}\rangle$  to the eigenstate in non-degenerate perturbation theory. Then answer the question in SN 5.2.

**A2. Anharmonic oscillator:** The Hamiltonian of a slightly anharmonic oscillator is given by the following Hamiltonian:

$$\hat{H} = \frac{\hat{p}^2}{2m} + \frac{m\omega^2 x^2}{2} + \alpha x^3 + \beta x^4 .$$

Calculate the correction to the energy of  $n^{\text{th}}$  state to the first non-vanishing orders in  $\alpha$  and  $\beta$ . Determine the range of values of  $\alpha$  and  $\beta$ , for which the perturbation approach is valid.

**A3. A bound particle in the electric field.** A particle with charge  $q$  and mass  $m$  is in ground energy state inside a one-dimensional infinite square well with width  $2a$ , centered at  $x=0$ . Find the first- and second-order shifts of the ground level, if this particle is placed inside a uniform electric field  $E$ .