Phys 521 Quantum Mechanics I **Fall 2011**

Homework Assignment #6 **Due Tuesday, November 15**
(40 points) **(at lecture)**

6.1 (10 points) Challenge problem (a). Consider a two-level system that has unperturbed Hamiltonian

$$H_0 = \frac{1}{2}\hbar\omega\big(|+\rangle\langle+| - |-\rangle\langle-|\big) \,,$$

where $|+\rangle$ and $|-\rangle$ are the unperturbed energy eigenstates, with corresponding unperturbed energy eigenvalues $\pm\frac{1}{2}\hbar\omega$. Suppose the system is perturbed so that its total Hamiltonian is $H = H_0 + V$; in the $|\pm\rangle$ basis the *nonzero* matrix elements of the perturbation V are

$$\langle+|V|-\rangle = \langle-|V|+\rangle = \hbar\gamma \,,$$

where γ is real.

(a) *Give* the matrix representation of H in the basis consisting of $|+\rangle$ and $|-\rangle$.

(b) *Find* the eigenvalues and eigenvectors of H. Write the eigenvectors in the $|\pm\rangle$ basis.

(c) Let the initial state of the system be $|\psi(0)\rangle = |+\rangle$. *Derive* the probability $\mathcal{P}(t)$ that the system is in the state $|+\rangle$ at time t.