Homework V - PHYS652

1. Given a spin system with Hamiltonian, $H = A + B\frac{\mathbf{S}_1 \circ \mathbf{S}_2}{\hbar^2} + C\frac{S_{1z}+S_{2z}}{\hbar}$, with A, B, C constants. Find the eigenvalues and eigenstates if
   (i) both particles have spin 1/2, i.e. $s_1 = 1/2$ and $s_2 = 1/2$,
   (ii) one particle has $s_1 = 1$ and the other $s_2 = 1/2$,

2. shankar: 15.2.5 (+ interpretation)

3. Given two non-interacting particles in an infinite square well potential that also have a spin ($s_i = 1/2$).
   (i) assume the particles are not distinguishable, determine the 4 lowest energy values, their degeneracy, and the corresponding states, $|n_1 n_2 > \chi$
   (ii) assume the particles are identical bosons, determine the 4 lowest energy values, their degeneracy, and the corresponding states, $|n_1 n_2 > \chi$
   (ii) assume the particles are identical fermions, determine the 4 lowest energy values, their degeneracy, and the corresponding states, $|n_1 n_2 > \chi$

4. a) shankar: 16.1.1
   b) E_f is the energy level of the first excited state. Prove that $E_f \leq \ < \psi|H|\psi >$ for a trial function ψ that is orthogonal to the ground state trial function ψ_g, $< \psi_g|\psi >= 0$.
   c) Choose a good trial function for the first excited state (problem a), motivate the physics captured by the trial function, and derive an estimate for the energy of the first excited state.