2002S Homework #04

Due 05/07/2002

1. For a hydrogen atom in a uniform electric field, show that the energy of a state with *l=n-1*, *m=n-1* does not change to the first order in the field.

2. A plane rotator with moment of inertia *I* (thus its unperturbed Hamiltonian $H_0 = L_z^2/2I$) and electric dipole moment ***d*** is placed in a uniform electric field ***E***, in the plane of rotation. Consider ***E*** to be a perturbation and evaluate the first non-vanishing correction to the energy levels of the rotator.
   Hint: you have to calculate to the second order in perturbation.

3. The Hamiltonian for an electron in a hydrogen atom subject to a constant magnetic field ***B,*** is, with the neglect of spin, $H = \frac{\vec{p}^2}{2m} - \frac{e^2}{r} + \left(\frac{e}{2mc}\right)\vec{L}\cdot\vec{B}$, where ***L*** is the angular momentum operator. In the absence of the magnetic field, there will be a single line in the transition from an (*n=4, l=3*) to an (*n=3, l=2*) state. What will be the effect of the magnetic field on that line? Sketch the new spectrum and the possible transitions. How many lines will there be?