PROBLEM SET 4, BCMB/CHEM 8190

1) Use density matrix methods to examine magnetization for a pair of spin ½ nuclei (spin 1 and spin 2) in a magnetic field B_0 along the *z*-axis. The first spin listed oscillates at ω_1 (Ω_1) and the second at ω_2 (Ω_1). Assume the scalar coupling is small and can be neglected.

a). Show the elements of an equilibrium deviation density matrix (sigma) in the simple product basis.

b). Calculate equilibrium *z* magnetization using matrix methods.

2)
a) For the same pair of spins as is (1) show in product operator notation, the effect of a 90° RF pulse along the +*y* axis on the density matrix represented by the $\mathbf{I}_{1x}\mathbf{I}_{2z}$ product operator (assume the pulse excites both spins equally).

b) Show the density matrix equivalent (fill in elements of matrix) of the result in a two spin ½ system and sketch the Fourier transformed spectrum that would result from observing x magnetization.

3) Using product operators for a pair of spin 1/2 nuclei ($\mathbf{I}_1$ and $\mathbf{I}_2$, i.e. ^{1}H and ^{15}N, respectively) identify the operators evolving during t_1 that are detectable during t_2 as $\mathbf{I}_1$ spin magnetization (not $\mathbf{I}_2$ spin magnetization). The two spins are scalar coupled with value *J* and τ is set to 1/(4J).