Problems 2 Many Body Physics (Due on Thursday October 16 th)

We are going to use the mathematica pogram which we constructed last week to practice the evaluation of several many body observables.

So take the one dimensional Hubbard model with 4 sites and periodic boundary conditions, at half filling (2 up particles and 2 down particles).

Let us evaluate the following quantities for t=1, and U=, 4 and 8 and plot them vs U.

a) kinetic energy per site b) interaction energy per site c) $\frac{1}{N_s}\sum_i < S_i.S_{i+1} >$, average spin exchange energy.

Notice that observables are represented by operators, and you are supposed to calculate their values by taking expectation values in the GROUND STATE.

Can you explain qualitatively the trends you see in your results?