Physics 220: Problem Set 1  
due April 12, 2012.

1. Show by direct calculation that in MFT the susceptibility diverges like $\chi \sim A/(T - T_c)$ and the specific heat has a jump discontinuity, as claimed in class.

2. Use the transfer matrix technique to calculate the spin-spin correlation function for the 1d classical Ising model, $\langle \sigma_i \sigma_j \rangle$, as a function of $|i - j|$ and $K = \beta J$. Extract the correlation length as a function of $K$.

3. Carry out Curie-Weiss MFT at zero temperature for the quantum transverse field Ising chain. That is, decouple the exchange term ($J$ term) to reduce the problem to that of independent spins in both a longitudinal (along $z$ - this is the effective exchange field) and transverse (along $x$) field. Put each of these spins in its ground state (since it is $T = 0$), and make your solution self-consistent. Find the quantum critical point in mean-field theory and find the longitudinal susceptibility, $-\frac{1}{L} \frac{\partial^2 E}{\partial h^2}$ (here $E$ is the ground state energy), in the same approximation.