1/24/07 Homework 2. Due Jan 29

1. In class, we considered $\langle T\phi(x_1)\phi(x_2)\rangle$ to order λ in $\lambda\phi^4$ scalar field theory. Now consider similarly $\langle T\phi(x_1)\phi(x_2)\phi(x_3)\phi(x_4)\rangle$ to order λ. As in class, use the generating functional $Z[J]$ to do this problem. Connect the results of taking the $\delta/\delta J$'s with the diagrammatic notation, being careful with the coefficients. Show that this gives the Feynman rules that you know, e.g. one diagram is the 4-point vertex, weighted by $-i\lambda$. Verify that there are also disconnected contributions which involve one regular propagator, and one propagator with a loop correction, which is just the $O(\lambda)$ 2-point function that we had in class. Finally, there is the bubble diagram contribution, which cancels in the end (from the $1/Z[J]$ in our rules for using the generating functional). You don't need to evaluate the actual loop integrals for this problem, the point is just to check the relation between the generating functional and the diagrams, including keeping track of the coefficients.

2. Now consider $\langle T\phi(x_1)\phi(x_2)\rangle$ to order λ^2. Again compute this using the generating functional. Again, the point is just to connect the J derivatives with the diagrams. Draw all the diagrams, and keep track of the combinatoric factors. If you're careful, you'll get the correct symmetry factors for the different diagrams.