Physics 428 – Problem Set # 2

(due Monday, October 29)

1. Srednicki # 6.1b, 7.4, 8.7

2. Consider the Klein-Gordon field coupled to an external source. The corresponding equation of motion is

$$\left\{\partial^2 + m^2\right\}\phi(x) = j(x).$$

   - Solve for the Green's function of this differential equation; the Green's function is the solution for $j(x) = \delta^{(4)}(x)$ (Hint: use a Fourier transform).
   - You should notice a problem with your solution. Solve this by imposing the condition $G(x) = 0$ for $x^0 < 0$. This is called the *retarded* Green's function, implying that there is no effect from the source until it turns on at time $x^0 = 0$.
   - Write down the general solution for the Klein-Gordon equation coupled to an arbitrary source $j(x)$ using the Green's function. Your solution should be in terms of a mode expansion like for the uncoupled field.
   - Assume that the source was switched on and then off at some time in the past. What is the Hamiltonian? What is the differential probability that the source produces a particle with momentum $\vec{p}$?