QFT-I problem set 3

(Fawad Hassan)

Due date: May 04, 2007

1. Problem 7.4 (page 136) from Mandl and Shaw
2. Problem 8.1 (page 171) from Mandl and Shaw
3. Problem 8.2 (page 172) from Mandl and Shaw
4. Compute the differential cross section for Bhabha scattering in the high-energy limit, showing the details of your calculation.
5. Consider the theory of a real scalar field $\phi(x)$ described by the Lagrangian density

$$\mathcal{L} = \mathcal{L}_0 + \mathcal{L}_I$$

where $\mathcal{L}_0 = \partial_\mu \phi \partial^\mu \phi - m^2 \phi^2$ is the free-field part and $\mathcal{L}_I = \frac{g}{4!}[\phi(x)]^4$ is the interaction Lagrangian density. Write down the second order term in the S-matrix expansion, $S^{(2)}$, and expand it using Wick's theorem. Draw the connected Feynman diagrams corresponding to terms containing 1, 2, 3 and 4 contractions and with, respectively, 3, 2, 1 and 0 particles in the initial state going to as many particles in the final state. Compute how many times a given diagram will arise in $S^{(2)}$ (Hint: this consists of the number of ways that the contractions can be formed and the number of ways that the uncontracted fields can connect the given initial and final states).