Problem Set 6 (due Apr 14, 2014)

1. **(Decay rates)** Consider a theory of two scalar fields

$$\begin{aligned} \mathcal{L} = & \frac{1}{2}\partial_\mu \Phi \partial^\mu \Phi - M_\Phi^2 \frac{1}{2}\Phi\Phi \\ & + \frac{1}{2}\partial_\mu \phi \partial^\mu \phi - m_\phi^2 \frac{1}{2}\phi\phi - \frac{\lambda_3}{2!}\Phi\phi^2 \end{aligned} \tag{1}$$

   (a) Rescale and shift the fields appropriately to rewrite the lagrangian in terms of renormalized fields and constants. Do you need to shift ϕ?

   (b) Separate out the free renormalized lagrangian and the conterterms and give the Feynman rules

   (c) Give renormalization conditions for the one-point correlators, $\langle \Phi \rangle$, $\langle \phi \rangle$, the two point correlators, $\langle \Phi\Phi \rangle$, $\langle \phi\phi \rangle$, $\langle \Phi\phi \rangle$, and the three point correlators

   (d) Assume that (renormalized) $M > 2 \times m$. Calculate the matrix element describing the decay of Φ to two ϕs to the lowest order in λ_3. What is the order of the correction to the matrix element?

   (e) Give the expression for the differential decay rate and integrate over phase space to calculate the total decay rate

2. **(Compton scattering)** Problem 11.2 Srednicki