Particle Physics: Assignment # 5

Due Tuesday 03/01/15

1 The interaction Lagrangian for a neutral scalar particle H with field ϕ with the electron e with field ψ is $\mathcal{L}_I(x) = -\lambda\phi(x)\bar{\psi}(x)\psi(x)$. In this interaction compute the unpolarized cross section for $e^+e^- \to H$ (this is, draw the tree level diagram, obtain the corresponding amplitude using the FR's, and obtain the unpolarized square amplitude using the techiniques given in class and integrate the phase space). Show that it verifies that

$$\sigma(e^+e^- \to H) = \frac{4\pi^2}{M_H^3}\Gamma(H \to e^+e^-)\delta(1 - \frac{s}{M_H^2}) \tag{1}$$

2 Draw the tree level QED Feynman diagrams and use the Feynman rules to write the amplitude M of the following processes (For each particle (p_i, s_i) or (p_i, λ_i) labels its four-momentum and its helicity)
- label the momenta and particles in the graphs according to the notation I give (in drawing the diagram assume that times runs form left to right as it is done in class).
- Make sure that in each amplitude you specify the momentum in the propagator in terms of the momenta of the external legs
- justify what you write. You can consult all books which have these processes or related ones, but write the result in the notation I give you and with the time arrow as I said.

2.1 Moller Scattering of positrons: $e^+(p_1, s_1)\ e^+(p_2, s_2) \to e^+(p_3, s_3)\ e^+(p_4, s_4)$

2.2 Compton Scattering on positrons: $e^+(p_1, s_1)\ \gamma(p_2, \lambda_2) \to e^+(p_3, s_3)\ \gamma(p_4, \lambda_4)$

2.3 Pair annihilation: $e^-(p_1, s_1)\ e^+(p_2, s_2) \to \gamma(p_3, \lambda_3)\ \gamma(p_4, \lambda_4)$