Introduction to Particle Physics
Homework 5

1. Griffiths problem 7.50.

2. Consider the annihilation process $e^+e^- \to \mu^+\mu^-$. Neglect all masses, use crossing symmetry, and show that the differential cross section for this process may be written in terms of the Mandelstam variables as $\frac{d\sigma}{d\Omega} = \frac{\alpha^2}{2s}\frac{\left(t^2+u^2\right)}{s^2}$, where α is the fine structure constant.

3. Use the prescription for obtaining the Feynman rules from the Lagrangian to show that the vertex factors for the quark-gluon and triple gluon vertices are, respectively, $-ig\gamma_\mu(T_\alpha)_{ij}$ and $-gf_{abc}[g_{\mu\nu}(p_1-p_2)_\lambda + g_{\nu\lambda}(p_2-p_3)_\mu + g_{\lambda\mu}(p_3-p_1)_\nu$, where the Gell-Mann matrices, $\lambda_\alpha/2$, are the conventional choice for the T_α.

4. The Lagrangian for three interacting real fields ϕ_1, ϕ_2, ϕ_3 is $L = \frac{1}{2}\left(\partial_\mu\phi_i\right)^2 - \frac{1}{2}\mu^2\phi_i^2 - \frac{1}{4}\lambda\left(\phi_i^2\right)^2$, with $\mu_2 < 0$ and $\lambda > 0$, and where a summation over i is implied. Show that it describes a massive field of mass $\sqrt{-2\mu^2}$ and two massless Goldstone bosons.