Week 8 (due March 1)

1. Prove eq. (5.9) in Peskin-Schroeder.

2. Consider a toy version of $e^+e^- \to \mu^+\mu^-$ scattering, where all particles involved are replaced with scalars (i.e. they all have spin 0 instead of spin 1/2). The Feynman rules for scalar QED have been derived in class.

(a) Show that the scattering amplitude is independent of the α parameter in the photon propagator.

(b) Compute the differential cross-section as a function of the scattering angle in the center-of-mass frame. The computation is so simple that there is no need to neglect the masses of either e or μ. What is the characteristic feature of the angular dependence of the cross-section compared to the spin-1/2 case?

3. Consider the elastic scattering $e^-e^- \to e^-e^-$ (this process is called Møller scattering).

(a) Draw all the relevant Feynman diagrams describing this process at leading order in perturbation theory and write down the corresponding analytic expressions.

(b) Compute the spin-averaged cross-section for Møller scattering in the high-energy limit (i.e. neglecting the electron mass). When squaring the amplitude, be sure to include not only the absolute-value squared of contributions of individual Feynman diagrams, but also the terms arising from interference between different diagrams.