

PHY 5667 : Quantum Field Theory A, Fall 2006

November 30th, 2006

Final Exam

(due Thursday December 14th, 2006, by noon, ET.)

1. Consider a quantum field theory containing a fermion field (ψ) and a scalar field (ϕ) with interaction $\mathcal{L}_{int} = -ig\bar{\psi}\gamma^5\psi\phi$, in $d=4$ space-time dimensions.
 - 1.a) Write the Lagrangian and the corresponding Feynman rules.
 - 1.b) Calculate the first order corrections to the fermion and scalar propagators, considering only the UV divergent part. Show how the UV divergences of both propagators can be reabsorbed into a redefinition of the fermion/scalar fields and of their masses.
 - 1.c) Calculate the first order corrections to the interaction vertex $ig\bar{\psi}\gamma^5\psi\phi$, considering only the UV divergent part. Show how the UV divergences can be reabsorbed into a redefinition of the coupling g .
 - 1.d) At one loop, there is one more UV divergent diagram, corresponding to a four-scalar interaction. Draw the diagram and calculate its UV divergence. Explain why this divergence cannot be reabsorbed into a reparametrization of the Lagrangian. How should the theory (i.e. the Lagrangian) be modified for this to be possible?

To calculate the UV divergent integrals you can use either Pauli-Villars regularization or dimensional regularization.