UNIVERSITY OF CALIFORNIA, SANTA BARBARA
Department of Physics

Physics 221C **Quantum Field Theory** **Spring 2007**

Prof: Joe Polchinski joep@kitp.ucsb.edu
Office hours: Kohn 2319, Th 3:30-4:30 (or email/see me after class to set up a time)

TA: Richard Eager

ASSIGNMENT #9
Due: Friday, June 8, 5pm in TA's mailbox

1. a) Show that the Standard Model (renormalizable terms only) has a non-anomalous $U(1)'$ global symmetry, in addition to the gauge symmetries (the prime is to distinguish it from the gauged $U(1)$): assign arbitrary $U(1)'$ charges to each fermion multiplet (but assume that the charges are the same in each generation), and solve the condition that every anomaly with one global current and two gauge currents vanishes. What charge must the Higgs doublet have, in order that the Yukawa couplings be invariant?

b) How does the dimension-5 term that generates the neutrino masses behave under this symmetry?

c) Show that if you were to gauge this symmetry there would be an anomaly, but that all anomalies would cancel if you include a left-handed anti-neutino with the right $U(1)'$ charge.