Physics 217. Quantum Field Theory. Professor Dine

Fall, 2013. Homework Set 2

Due Thursday, Oct. 24

By the end of this week, we will have finished Chapter 3 of Peskin and Schroeder and started the material of chapter 4.
Read the handout on quantization of the Dirac Field.

1. Do the exercises on the handout on the Dirac equation.

2. Construct the energy-momentum tensor for the free Dirac field. Verify that it reproduces the Hamiltonian we used in class. Construct the momentum operator in terms of creation and annihilation operators for electrons and positrons.

3. More on the Dirac equation: Verify the commutation relations of $J^{\mu\nu} = i(x^\mu \partial^\nu - x^\nu \partial^\mu)$ as we wrote them in class. Similarly check the commutation relations for the matrices

$$(\mathcal{S}^{\mu\nu})^\alpha_\beta = i(g^{\mu\alpha} g^\nu_\beta - g^\mu_\beta g^{\nu\alpha}).$$

   Finally, verify the commutation relations for

$$S^{\mu\nu} = \frac{-i}{4}[\gamma^\mu, \gamma^\nu],$$

   the Lorentz generator constructed in class in terms of the Dirac matrices. Verify that $\bar{\psi}\gamma^\mu\gamma^\nu\psi$ transforms as a second-rank tensor.

4. PS 3.2