Reading: Sections 3.1, 3.2 from the textbook and class notes. Alternative sources: Chapter 2 in Ryder, Chapter 1 in Ramond.

Problem 1. Lorentz group. Problem 3.1 in Peskin&Schroeder. For part (a), use the commutation relations between the generators of rotations ($J^i \equiv L^i$) and boosts ($K^i$) which we derived in class and show that they are equivalent to (3.17). Then derive the algebra of

$$\tilde{J}_+ \equiv \tilde{A} \equiv \frac{1}{2} (\tilde{J} + i\tilde{K}), \quad \tilde{J}_- \equiv \tilde{B} \equiv \frac{1}{2} (\tilde{J} - i\tilde{K}).$$

Problem 2. Spinor products. Problem 3.3 in Peskin&Schroeder.

Problem 3. Symmetries of the Dirac Lagrangian. Consider the Dirac Lagrangian (3.34):

$$\mathcal{L}_{\text{Dirac}} = \bar{\psi}(i\gamma^\mu \partial_\mu - m)\psi.$$

(a) Show that the transformation

$$\psi(x) \to e^{i\alpha} \psi(x)$$

is a symmetry of the Lagrangian. Find the corresponding Noether current and check that it is indeed conserved.

(b) Now consider the transformation

$$\psi(x) \to e^{i\alpha\gamma^5} \psi(x)$$

and again find the corresponding Noether current. Is it conserved? Consider two cases: $m = 0$ and $m \neq 0$. 
