Assignment 1:

The Lagrangian for real scalar field is

$$\mathscr{L} = \frac{1}{2}\eta^{\mu\nu}(\partial_\mu\phi)(\partial_\nu\phi) - \frac{1}{2}m^2\phi^2$$

Explicitly calculate the equation of motion.

Assignment 2:

Let us consider $\psi(x)$ as relativistic wave function of a particle. Define

$$j^\mu = (j^0, j^i)$$

$$j^0 = \frac{i}{2m}[\psi^*(\partial_t\psi) - (\partial_t\psi^*)\psi]$$

$$j^i = -\frac{i}{2m}[\psi^*(\partial_i\psi) - (\partial_i\psi^*)\psi]$$

Show that $\partial_\mu j^\mu = 0$, which is the continuity equation.

Assignment 3:

The amplitude of propagation of a free and non-relativistic particle between x_0 and x_1 is

$$\mathscr{A}(t) = < x_1 \,|\, e^{-iHt} \,|\, x_0 >$$

Show that this has the following form

$$\mathscr{A}(t) = \frac{m^{3/2}}{(2\pi i t)^{3/2}} e^{im(x_1 - x_0)^2/2t}$$