Week 3 (due Oct. 18)

1. Consider free complex scalar field ϕ with mass m. The expansion of the field in terms of creation and annihilation operators is given in eq. (3.38) in Srednicky (Problem 3.5). Invert this formula and express $a_k, b_k, a_k^\dagger$ and $b_k^\dagger$ in terms of ϕ and $\phi^\dagger$.

2. Consider the 2-point time-ordered Green's function

$$G_2(x,y) = \langle 0|T(\phi(x)\phi(y))|0\rangle$$

for the free real scalar field ϕ. Show that G_2 satisfies

$$(-\partial_\mu\partial^\mu + m^2)G_2(x,y) = -i\delta^4(x-y)$$

without using the explicit expression for $G_2(x,y)$ as a Fourier-integral. Rather, use the fact that $\phi(x)$ satisfies the Klein-Gordon equation, plus the equal-time canonical commutation relations

$$[\phi(t,\vec{x}),\phi(t,\vec{y})] = 0, \quad [\partial_0\phi(t,\vec{x}),\partial_0\phi(t,\vec{y})] = 0, \quad [\phi(t,\vec{x}),\partial_0\phi(t,\vec{y})] = i\delta^3(\vec{x}-\vec{y}).$$