PHYS 5180: Homework 3 (due Thurs 4pm Feb. 5)

1. Consider a real scalar field ϕ with interaction Lagrangian $\mathscr{L}_{\text{int}} = \frac{\mu}{3!}\phi^3$. What is the mass dimension of μ? Evaluate the leading μ-dependent contributions to

$$\langle 0|T\Big(\phi_I(x)\phi_I(y)\ \exp\Big[i\int d^4z\,\mathscr{L}_I(z)\Big]\Big)|0\rangle$$

in terms of the Feynman propagator D_F. Draw the relevant Feynman diagrams.

2. Consider a complex scalar field ϕ. The Feynman propagator is

$$D_F(x-y) = \langle 0|T\big(\phi_I(x)\phi_I^*(y)\big)|0\rangle\,.$$

Show that $\langle 0|T\big(\phi_I(x)\phi_I(y)\big)|0\rangle = \langle 0|T\big(\phi_I^*(x)\phi_I^*(y)\big)|0\rangle = 0$.

Consider an interaction Lagrangian $\mathscr{L}_{\text{int}} = \frac{\lambda}{4}(\phi^*\phi)^2$. Compute the leading λ-dependent contribution to

$$\langle 0|T\Big(\phi_I(x)\phi_I^*(y)\ \exp\Big[i\int d^4z\,\mathscr{L}_I(z)\Big]\Big)|0\rangle$$

in terms of D_F. (Note: when drawing the propagator for a complex scalar, one draws an arrow on the line to indicate the flow of charge, since e.g. $\phi^*(y)$ creates a positive charge at y and $\phi(x)$ annihilates it at x.)

3. PS problem 4.1.