Northwestern University Department of Physics and Astronomy

# PHYSICS 428-2 QUANTUM FIELD THEORY II

Ian Low, Winter 2009

Course Webpage: `http://www.hep.anl.gov/ian/teaching/QFTII/QFT_Winter09.html`

*ASSIGNMENT #9*

Due at 3 PM, March 9th

(One page and two problems.)

**Reading Assignments:**
Sections 9.3, 9.4, 9.5, and 15.1 of Peskin and Schroeder.

**Problem 1**
Do Problem 9.1 of Peskin and Schroeder.

**Problem 2**
In class we derived the generating functional of an interacting scalar field theory with polynomial interactions $V(\phi)$:

$$Z[J] = \frac{1}{Z_0} e^{i\int d^4x\, V\left(-i\frac{\delta}{\delta J}\right)}\; Z_{free}[J],$$

where $Z_0$ is a normalization constant and $Z_{free}[J]$ is the generating functional of a free scalar

$$Z_{free}[J] = Z_0\, e^{-\frac{1}{2}\int d^4x d^4y\, J(x) D_F(x-y) J(y)}$$

Now let's consider a massive scalar with $\lambda\phi^4$ interaction: $V(\phi) = \lambda\phi^4/4!$.
(a) Compute the two-point function $G^{(2)}(p,-p)$ to order $\lambda^2$ using the generating functional $Z[J]$. You do not have to perform the loop integration. Instead, draw the Feynman diagrams corresponding to each contribution in the two-point function.
(b) Repeat (a) for the four-point function $G^{(4)}(p_1,p_2,p_3,p_4)$.