

# Homework Set No. 1, Physics 880.08

## Deadline – Wednesday, January 20, 2010

1. Consider real scalar  $\varphi^4$ -theory described by the Lagrangian density

$$\mathcal{L} = \frac{1}{2} \partial_\mu \varphi \partial^\mu \varphi - \frac{m^2}{2} \varphi^2 - \frac{\lambda}{4!} \varphi^4.$$

- a. (10 pts) Draw all connected Feynman diagrams contributing to the two-point function

$$\langle \psi_0 | T \varphi(x) \varphi(y) | \psi_0 \rangle$$

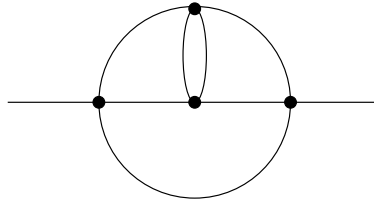
at the order  $\lambda^3$ . Find the symmetry factors for all the graphs.

- b. (15 pts) Draw all connected Feynman diagrams contributing to the four-point function

$$\langle \psi_0 | T \varphi(x_1) \varphi(x_2) \varphi(x_3) \varphi(x_4) | \psi_0 \rangle$$

up to the order  $\lambda^3$ . Calculate the symmetry factors.

- c. (5 pts) What is the symmetry factor of the following Feynman diagram?



2. Consider real scalar  $\varphi^3$ -theory described by the Lagrangian density

$$\mathcal{L} = \frac{1}{2} \partial_\mu \varphi \partial^\mu \varphi - \frac{m^2}{2} \varphi^2 - \frac{\lambda}{3!} \varphi^3.$$

- a. (10 pts) Draw all connected Feynman diagrams contributing to the two-point function

$$\langle \psi_0 | T \varphi(x) \varphi(y) | \psi_0 \rangle$$

up to the order  $\lambda^4$ . Find the symmetry factors.

- b. (10 pts) Draw all connected Feynman diagrams contributing to the three-point function

$$\langle \psi_0 | T \varphi(x_1) \varphi(x_2) \varphi(x_3) | \psi_0 \rangle$$

up to the order  $\lambda^3$ . Calculate the symmetry factors.