1 Calculate de derivatives on the last passage of pg 114 of the lecture notes, obtaining the last expression on that page.

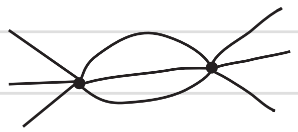
2 a Obtain the Feynman rules (in Euclidean momentum space) for a real scalar theory with interaction:

$$S_I(\phi) = \int d^4x \left[\frac{\lambda_3}{3!}\phi^3(x) + \frac{\lambda_6}{6!}\phi^6(x) \right] \qquad \lambda_3, \lambda_6 \ \text{CONST.}$$

How does the f6 part of the Feynman rules change if we define instead:

$$S_I(\phi) = \int d^4x \left[\ldots + \lambda_6' \phi^6(x) \right]$$

b Use the Feynman rules to write the $\tilde{G}_6(p_1, \ldots, p_6)$ contribution coming from:



3 Obtain the Feynman rules (in Euclidean momentum space) for a theory with N scalar fields (all of them massless, but distinguishable through some other interaction), with the following interaction:

$$S_I(\phi_1, \ldots, \phi_N) = \int d^4x \sum_{i=1}^{N} \sum_{j=1}^{N} \left[(\partial^\mu \phi_i)(\partial_\mu \phi_j)\, \phi_i\, (\partial^\mu \phi_j) \right]$$

this does NOT mean $\phi(x_1)$, as we normally use it.

In this case, there are really many different scalar fields, labelled by a "flavor" index a: $\phi_a(x)$, with a = 1... N