Physics 722, Spring 2019
Problem Set 2, due Thursday, Feb 7.

Consider the theory of a real scalar field coupled to a Dirac spinor field,

$$\mathcal{L} = \frac{1}{2}(\partial_\mu \tilde{\phi})^2 - \frac{m^2}{2}\tilde{\phi}^2 + \overline{\tilde{\psi}}(i\partial\!\!\!/ - M)\tilde{\psi} - g\,\overline{\tilde{\psi}}\tilde{\psi}\tilde{\phi} - \frac{g_3}{3!}\,\tilde{\phi}^3 - \frac{g_4}{4!}\,\tilde{\phi}^4 + \text{counterterms.}$$

Calculate the one-loop renormalized self energy $\widetilde{\Pi}(k^2)$ for the scalar field ϕ. $\widetilde{\Pi}(k^2)$ should satisfy the renormalization conditions $\widetilde{\Pi}(m^2) = 0$ and $d\widetilde{\Pi}/dk^2|_{k^2=m^2} = 0$. Your result should be left in terms of integrals over a single Feynman parameter.