1. First, solve problem **1**(d) of the previous homework set.

2. Second, an easy reading assignment: The 4–page note I distributed in class (also available on-line at the homework page). Make sure you understand all the algebra: You may need to perform a similar calculation in the future.

3. And now, a calculational exercise: Verify that at the one-loop level $\delta_1 = \delta_2$, including the finite parts of both counterterms.

   (a) Continue the classroom calculation of one-loop vertex correction for the special case of $q = 0$. Derive an exact formula for the $F_1^{1\,\text{loop}}(q^2 = 0)$ — and hence for the δ_1 counterterm — in D dimensions. Do not take the $D \to 4$ limit.

   To regularize the IR divergence, assume the photon to have a tiny but non-zero mass $m_\gamma \ll M_e$, hence photon propagator

$$\frac{-ig^{\mu\nu}}{k^2 - m_\gamma^2 + i0}\,. \tag{1}$$

   (b) And now calculate the $\Sigma^{1\,\text{loop}}(\not{p})$ for the electron in D dimensions, without taking the $D \to 4$ limit. Then evaluate the derivative $d\Sigma^{1\,\text{loop}}/d\not{p}$ for $\not{p} = M_e$ and hence the δ_2 counterterm.

   Note that for $\not{p} = m$, the derivative develops an infrared divergence. To regularize this divergence, use a tiny photon mass, exactly as in part (a).

   (c) Verify that $\delta_1 = \delta_2$ in any dimension D. If you do not achieve this equality, check your calculations for mistakes.

4. And finally, another reading assignment: §6.1 of the *Peskin & Schroeder* textbook. The soft-photon bremsstrahlung discussed there is important for understanding the infra-red divergences of QED.