This homework assignment is due on **October 6**. The maximum possible score of this homework, if not turned in by 5 pm that day, will be linearly decreased $N = N_{max}(1 - 0.2n)$, where $n$ is the number of days.

**Suggested reading:**

M. Peskin and D. Schroeder, “An Introduction to Quantum Field Theory” chapters 8-12.

**Problem 1: $\phi^3$-theory in 6-dimensions. Part I.**

Consider the $\phi^3$-theory in six space-time dimensions,

$$\mathcal{L} = \frac{1}{2}(\partial_{\mu}\phi)^2 - \frac{1}{2}m^2\phi^2 - \frac{g}{3!}\phi^3 - h\phi. \quad (1)$$

For this model,

(a) following what we did in class, determine the superficially divergent amplitudes. Write the renormalized Lagrangian density and derive the Feynman rules.

(b) Calculate the tadpole one-loop diagram and explain why the contribution of the tadpole diagrams can be ignored.

**Problem 2: Schwinger model**

Consider two-dimensional QED (one space and one time) with massless electrons, the so-called Schwinger model, which is given by the following Lagrangian,

$$\mathcal{L} = -\frac{1}{4}(F_{\mu\nu})^2 + i\bar{\psi}(\slashed{D} - ie\mathcal{A})\psi. \quad (2)$$

In this model,

(a) calculate the vacuum polarization at one loop. Use dimensional regularization and remember that you work in 1 + 1 space-time dimensions. What is the divergent part of this diagram?
(b) proceeding just like we did in class, find the full photon propagator and read off the mass of the photon (yes, the photon will get a mass in this model due to quantum corrections!).