Advanced Quantum Field Theory - Fall 1402: Mini Set TA: Hossein Mohammadi
Subject: Renormalization Warm-up, Feynman Rules
Instructor: Dr. Amin Faraji Due Date: dd/mm/yyyy

These are brief questions to warm you up with a quick review of Feynman rules before starting the renormalization section. All these questions could be answered in less than one page by watching the uploaded video or referring to Schwartz's textbook.

Problem 1: LSZ formula

Express the LSZ formula and its implications. (No formula is needed; just a formal definition and its application and implications in QFT is enough.)

Problem 2: Momentum Conservation in vertices

In a general vertex, show momentum conservation, or why $\delta^{(4)}(\sum p_{in} - \sum p_{out})$ appears in Feynman rules.

More specifically, show that by integrating on the vertex position in the figure below, you'll end up with a Dirac delta, which guarantees the momentum conservation. Notice that you just need $e^{\pm ip.x}$ part of the propagator, regardless of its spin.

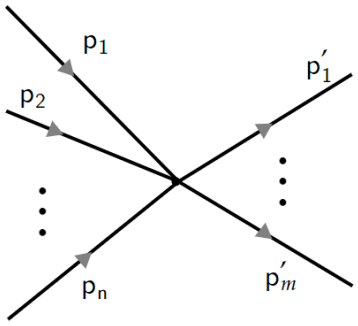

Figure 1: Momentum conservation - sketch of argument

Problem 3: Derivative coupling

Derive the Feynman rule of these two vertices in the figure 2. To be able to do so, I encourage you to look at the uploaded video.

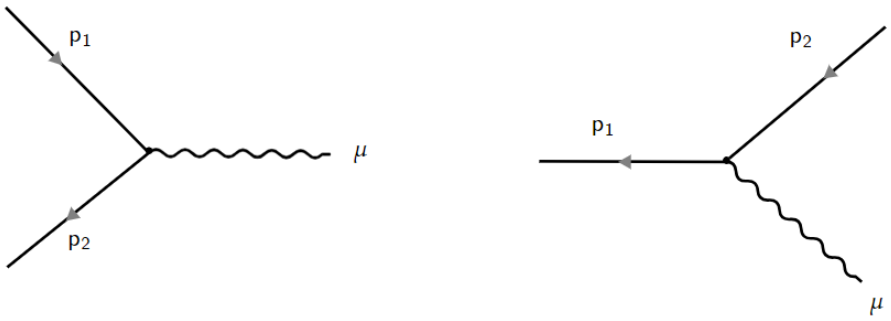

Figure 2: Scalar QED vertices.

Problem 4: Amplitudes

Write out the expressions for the amplitude of the following diagrams. The label below each one specifies the theory in which the amplitude should be written.

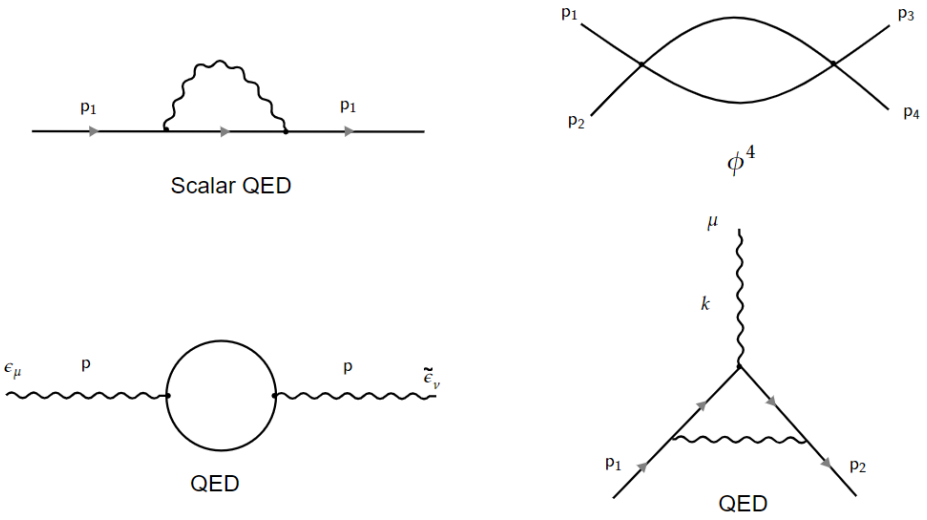

Figure 3: Amplitudes.