QFT Home Assignment # 3. Submission date 22.12.2021

1. Fill gaps through self-education: read Peskin and Schroeder, Chapters 4.5, 4.6, 7.1, 7.2, 7.3 (you may, but better not to, skip the fermion part).

2. Consider the following two models:

$$L_I = \frac{1}{2}\,\partial_\mu A \partial^\mu A - \frac{1}{2} m^2 A^2 - \frac{\lambda}{3!} A^3 \tag{1}$$

$$L_{II} = \frac{1}{2}\,\partial_\mu A \partial^\mu A + \frac{1}{2}\,\partial_\mu B \partial^\mu B - \frac{1}{2} m^2 A^2 - \frac{1}{2} m^2 B^2 - \frac{\mu}{2} B A^2 \tag{2}$$

We limit ourselves to diagrams with an even number of external A-lines (and no external B's). Let us pose the question whether we can make a distinction between the above models from knowledge of the amplitudes for its diagrams.

a). Show that λ and μ can be chosen such that the models I and II at tree level give identical 4-point functions.

b). Show that the 6-point function is different for the two models.

c). Show that at 1-loop level even the 2-point functions are different.

3. Consider the scalar field theory

$$L_I = \frac{1}{2}\left[\partial_\mu \phi_0 \partial^\mu \phi_0 + \partial_\mu \phi_1 \partial^\mu \phi_1 + \partial_\mu \phi_2 \partial^\mu \phi_2 - m_0^2 \phi_0^2 - m_1^2 \phi_1^2 - M^2 \phi_2^2 - \lambda_0 \phi_0 \phi_2^2 - \lambda_1 \phi_1 \phi_2^2\right] \tag{3}$$

Give the leading order expression for the $\phi_1 \to \phi_0 \phi_0$ amplitude

4. Peskin and Schroeder: Read Chapter 11.5 and related topics and establish the relation between exact propagator and 1PI graphs.