Quantum Field Theory 2 – Tutorial 5

Lectures: Jan Pawlowski J.Pawlowski@thphys.uni-heidelberg.de
Tutorials: Aleksandr Mikheev A.Mikheev@thphys.uni-heidelberg.de
Institut für Theoretische Physik, Uni Heidelberg tutorial date: week of 15.05.2023

Problem 1: Loop expansion as expansion in $\hbar$

In the exercise sheet 4, you derived an expression for the effective action in terms of a loop expansion,

$$\Gamma[\phi] = S[\phi] + \frac{1}{2}\,\mathrm{Tr}\ln S^{(2)}[\phi] + \dots, \tag{1}$$

using the integral representation

$$e^{-\Gamma[\phi]} = \int D\varphi\ \exp\left[-S[\phi+\varphi] + \int d^dx\ \frac{\delta\Gamma[\phi]}{\delta\phi(x)}\varphi(x)\right]. \tag{2}$$

Use the fact that the actions $S[\phi]$ and $\Gamma[\phi]$ are measured in units of $\hbar$ to show that the expansion in Eq. (2) can be considered as an expansion in $\hbar$.