

PROBLEMS FOR QUANTUM FIELD THEORY 2  
5. Tutorial

PROBLEM 1: *Loop expansion as expansion in  $\hbar$*

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

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

from the integral representation

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

Use the fact that the actions  $S[\phi]$  and  $\Gamma[\phi]$  are measured in units of  $\hbar$  to show that the expansion in Eq. (1) can be seen as an expansion in  $\hbar$ .