

PROBLEMS FOR QUANTUM FIELD THEORY 2
10. Sheet

Suggested reading before solving these problems: Chapter 5.1 in the script and/or chapter 16.5 in *Peskin & Schroeder*.

PROBLEM 1: *Gauge-Boson self energy 2*

On sheet 9 you computed the one-loop correction to the gauge-boson self energy in pure Yang-Mills theory (without fundamental fermions). For theories such as QCD there is an additional contribution from the quarks (or other fundamental fermions). Compute this in dimensional regularization, for Feynman gauge ($\xi = 1$) and for n_f fermion species, all in the same representation. (A similar calculation has been performed for QED in chapter 7.2 of the script for QFT1.)

PROBLEM 2: *Fermion self energy*

Consider now the one-loop correction to the fermion self-energy. Show that the corresponding expression is for arbitrary gauge parameter ξ

$$g^2 \int \frac{d^4 l}{(2\pi)^4} \gamma^\mu t^a \frac{-(l+k)_\sigma \gamma^\sigma}{(l+k)^2} \gamma^\nu t^a \frac{\delta^{\mu\nu} - (1-\xi)l^\mu l^\nu / l^2}{l^2}.$$

Evaluate this further in dimensional regularization and show that the result is regular for $d \rightarrow 4$ in Landau gauge with $\xi = 0$.