problem sheet 2
to be handed by Friday 6.5.2016 (12:00) to the letterbox 37 (foyer of Staudingerweg 7)

1. **Renormalisation of the fermion propagator (70 P.)**

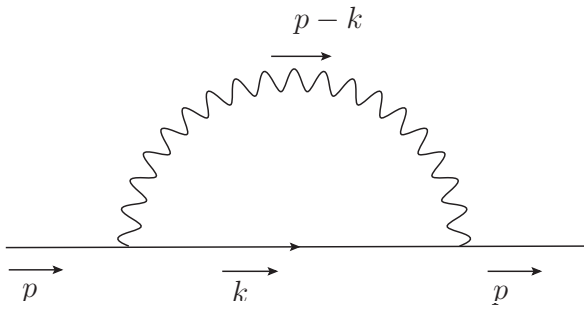

Figure 1: Loop correction to the fermion propagator on one-loop level.

Calculate the diagram scetched in figure 1:

- Write down the amplitude using Feynman rules, do not include the propagators of the external fermion lines.
- Introduce Feynman parameters to combine the denominator.
- Complete the square in the denominator, shifting $k \to \ell$. The denominator should become
$$[\ell^2 - \Delta + i\epsilon]^2 \,, \tag{1}$$
with
$$\ell = k - xp \qquad \text{and} \qquad \Delta = -x(1-x)p^2 + (1-x)m^2 \,. \tag{2}$$
- Rewrite the numerator in terms of ℓ, remember you can drop odd powers.
- Solve the momentum integral using Wick rotation and dimensional regularisation. You do not have to solve the Feynman parameter integral!

2. **Gordon identity (30 P.)**

In the lecture you used the Gordon identity

$$\bar{u}(p')\gamma^\mu u(p) = \bar{u}(p') \left[\frac{p'^\mu + p^\mu}{2m} + \frac{i\sigma^{\mu\nu} q_\nu}{2m} \right] u(p) \,, \tag{3}$$

where $q = p - p'$, to determine the structure of the electron vertex function Γ^μ (see section 8.1).

Use the anticommutation relations of the gamma matrices and the Dirac equation to proof this identity.