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## Exercises Quantum Field Theory II

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<http://www.th.physik.uni-bonn.de/klemm/qft2ws1516/>

–HOMEWORK–

### 1 Yukawa corrections (20 pts.)

Consider a theory of elementary fermions that couple both to QED and to a Yukawa field  $\phi$ :

$$H_{int} = \int d^3x \frac{\lambda}{\sqrt{2}} \phi \bar{\psi} \psi + \int d^3x e A_\mu \bar{\psi} \gamma^\mu \psi. \quad (1)$$

1. Verify that the contribution to  $Z_1$  from the vertex diagram with a virtual  $\phi$  equals the contribution to  $Z_2$  from the diagram with a virtual  $\phi$ . Use dimensional regularization. Is the Ward identity generally true in this theory? **10 pts.**
2. Now consider the renormalization of the  $\phi \bar{\psi} \psi$  vertex. Show that the rescaling of this vertex at  $q^2 = 0$  is *not* cancelled by the correction to  $Z_2$ . (It suffices to compute the ultraviolet-divergent parts of the diagrams.) In this theory, the vertex and field-strength rescaling give additional shifts of the observable coupling constant relative to its bare value. **10 pts.**