BUSSTEPP 2012
Standard Model and Beyond
Exercises

Part II
The Standard Model as an effective theory and Grand Unification

1 The Weinberg operator

Show that the SM effective lagrangian contains a single dimension 5 operator: $c_{ij}(l_i h)(l_j h)/\Lambda$. Consider only operators that do not contain derivatives and gauge fields.

2 Baryon number violation

Show that Baryon number violation in the SM effective lagrangian requires at least dimension 6 operators. Show that Baryon number violation with no lepton number violation requires at least dimension 9 operators.

3 SU(5) breaking

Let Σ be a real (i.e. hermitian) scalar adjoint field of SU(5). Determine the most general form of the vev of Σ that breaks SU(5) to the SM gauge group.

4 SM fermion embedding in SU(5)

Using the fact that $d^c \to U_3^* d^c$ under $U_3 \in \mathrm{SU}(3)_c$, $l \to U_2 l$ under $U_2 \in \mathrm{SU}(2)_L$, and $\overline{F} \to U_5^* \overline{F}$ under $U_5 \in \mathrm{SU}(5)$, determine the precise embedding of d^c, l in F.