Exercise 6

1. Write out all the quartic interactions in the Lagrangian that corresponds to the superpotential

$$
\begin{aligned}
W_{\text{Higgs}} \;=\;\; & y_t(\bar{t}tH_u^0 - \bar{t}bH_u^+) - y_b(\bar{b}tH_d^- - \bar{b}bH_d^0) \\
& -y_\tau(\bar{\tau}\nu_\tau H_d^- - \bar{\tau}\tau H_d^0) + \mu(H_u^+ H_d^- - H_u^0 H_d^0) \;.
\end{aligned}
\tag{1}
$$

2. Derive the D-term quartic potential in eqn (4.21) using $H_u = (H_u^+, H_u^0)$, and $H_d = (H_d^0, H_d^-)$.

3. Calculate the D-term contribution

$$
\delta_f = -gT_f^3\langle D^3\rangle - g'Y_f\langle D'\rangle = (T_f^3 - Q_f s_W^2)\cos 2\beta\, M_Z^2\;,
\tag{2}
$$

to the squark or slepton mass squared matrix for a sfermion with diagonal $SU(2)_L$ charge T_f^3 and electric charge Q_f.