# Particle Physics Phenomenology II

## FS 11, Series 1

Due date: 28.02.2011, 1 pm

**Exercise 1** For the process $e^+e^- \to \gamma, Z \to f\bar{f}$, where the f stands for an arbitrary fermion (quark, lepton or neutrino) show that the differential cross section is given by

$$
\frac{d\sigma}{d\cos\theta} = \frac{\pi\alpha^2}{2s}\Bigg[(1+\cos^2\theta)\big\{Q_f^2 - 2Q_f V_e V_f \chi_1(s)
$$
$$
+ (A_e^2 + V_e^2)(A_f^2 + V_f^2)\chi_2(s)\big\}
$$
$$
+ \cos\theta\big\{-4Q_f A_e A_f \chi_1(s) + 8A_e V_e A_f V_f \chi_2(s)\big\}\Bigg]
$$

where

$$
\chi_1(s) = \kappa\frac{s}{(s - M_z^2)}
$$

and

$$
\chi_2(s) = \kappa^2\frac{s^2}{(s - M_z^2)^2}
$$

where

$$
\kappa = \sqrt{2}\frac{G_F M_z^2}{16\pi\alpha}.
$$

You should ignore interference effects and set the quark masses to zero.