Physics 565 - Spring 2010, Assignment #9, Due April 21th

1. Show that the total cross section for $e^+e^- \to f\overline{f}$ ($f \neq e$) at $\sqrt{s} = M_Z$ can be written

$$\sigma_{f\overline{f}} = \frac{12\pi\Gamma_e\Gamma_f}{M_Z^2\Gamma_Z^2}$$

where

$$\Gamma_f = N_c\frac{G_F M_Z^3}{6\pi\sqrt{2}}\left((c_V^f)^2 + (c_A^f)^2\right)$$

2. Prepare a graphs showing A_{FB} as a function of $\sqrt{s}$ for the following processes:

$$e^+e^- \to \mu^+\mu^- \quad (1)$$
$$e^+e^- \to b\overline{b} \quad (2)$$
$$e^+e^- \to c\overline{c} \quad (3)$$

For each graph, assume the following three different values of $\sin^2\theta_W$: 0.231, 0.22 and 0.24, so as to demonstrate the sensitivity of these measurements in the determination of $\sin^2\theta_W$. What experimental complications would one encounter when trying to measure A_{FB} for these three processes? Which would be the easiest to measure? Which would be the most difficult?