PRE-LAB QUESTIONS

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Q5.1. We can use, $\Gamma_f = \frac{N_c^f \sqrt{2}}{12\pi} G_F M_{Z_0}^3 \left((g_V^f)^2 + (g_a^f)^2 \right)$

$\Gamma_e = 84.1$ MeV

$\Gamma_\nu = 167$ MeV

$\Gamma_{u,c} = 288$ MeV

$\Gamma_{d,s,b} = 371$ MeV

a) $\Gamma(Z^0 \to e^+e^-) = 84.1$ MeV

b) $\Gamma(Z^0 \to \mu^+\mu^-) = 84.1$ MeV

c) $\Gamma(Z^0 \to \tau^+\tau^-) = 84.1$ MeV

d) $\Gamma(Z^0 \to u\bar{u}) = 288$ MeV

$\Gamma(Z^0 \to d\bar{d}) = 371$ MeV and so on

Q5.2

a) total decay width = 2442.3 MeV

b) hadronic decay width = 1689 MeV

c) charged decay width = 252.3 MeV

d) Neutral decay width = 501 MeV

e) Partial cross section at the maximum of the resonance is given by $\sigma_f^{peak} = \frac{12\pi}{M_Z^2} \frac{\Gamma_e}{\Gamma_Z} \frac{\Gamma_f}{\Gamma_Z}$

$I_{hadronic} = 10.8 \times 10^{-11}$ MeV^{-2}

$I_{charged} = 1.6 \times 10^{-11}$ MeV^{-2}

$I_{neutral} = 3.2 \times 10^{-11}$

Q5.3

We have decay into additional pair of light fermions.

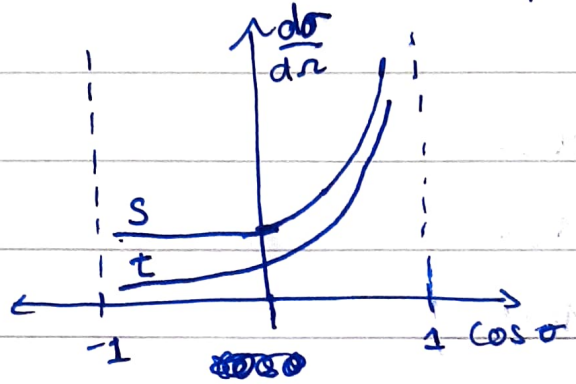
$$\left(\frac{\Gamma_{tot} + \Gamma_e + \Gamma_\nu + \Gamma_u + \Gamma_d}{\Gamma_{tot}} - 1 \right) \times 100$$

$= 58\%$

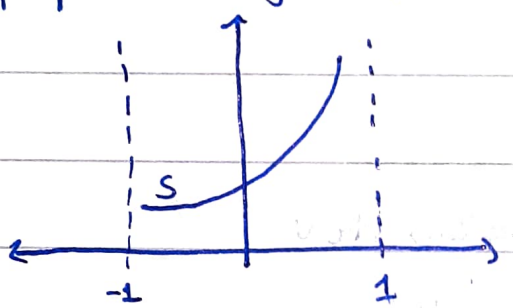
Q5.4

From the manual, S-channel has a $(1+\cos^2\theta)$ dependence and t-channel has a $(1-\cos\theta)^{-1}$ dependence

* $e^+e^- \to e^+e^-$ (both S, t possible)



* $e^+e^- \to \mu^+\mu^-$ (only s possible)



Q5.5

We use, $A_{FB}^f = \frac{-3}{2} \frac{a_e \cdot a_f}{(v_e^2+a_e^2)} \frac{Q_f \cdot Re(\chi)}{(v_f^2 \cdot a_f^2)}$

GeV/Angle	0.21	0.23	0.25
89.225	-0.0215	-0.0234	-0.0250
91.225	-0.0211	-0.0229	-0.0244
93.225	-0.0220	-0.0239	-0.0255