Physics 564 - Assignment #3

1. Draw the quark-level diagrams for the weak decays of the D^0 meson to the $K^-\pi^+$, $\pi^-\pi^+$ and $K^+\pi^-$ final states. Classify the decays as Cabibbo allowed, Cabibbo suppressed and doubly Cabibbo suppressed. Calculate the relative branching fractions to these final states and compare with experimental measurements.

2.Show that the ratio of partial widths for the processes $\tau^- \to \pi^-\nu_\tau$ and $\tau^- \to K^-\nu_\tau$ can be used to estimate the Cabibbo angle, θ_C. Use the measured branching fractions to estimate θ_C.

3.The partial width for the leptonic decay of a μ or τ lepton can be expressed

$$\Gamma(\ell^- \to e^-\overline{\nu}_e\nu_\ell) = \frac{G_\ell^2 m_\ell^5}{192\pi^3}.$$

This expression provides a way to measure the coupling constant, G_ℓ. Use the measured partial widths for $\mu^- \to e^-\overline{\nu}_e\nu_\mu$ and $\tau^- \to e^-\overline{\nu}_e\nu_\tau$ to calculate the ratio G_μ/G_τ, demonstrating that weak interactions involving leptons can be described by a single universal coupling constant.

4.The partial width for β-decay process $n \to pe^-\overline{\nu}_e$ can be written

$$\Gamma = \frac{G^2 E_0^5}{30\pi^3}$$

where $E_0 = m_n - m_p$. Use the analagous expression for the semileptonic decay $\Sigma^- \to ne^-\overline{\nu}_e$ to calculate the ratio of weak couplings for the two processes. Argue that the ratio should be proportional to $\tan\theta_C$ and use the measured partial widths to estimate θ_C.