Physics G6050 – Assignment 6

Not to be handed in

Problems from Griffiths:

Chpt 8 – 8.5, 8.13, 8.15, 8.16
Chpt 9 – 9.6, 9.13, 9.18
Chpt 10 – 10.26

Other Problems:

(1) Given that the weak eigenstates ν_μ and ν_e are mixtures of the mass eigenstates, ν_1 and ν_2 with masses m_1 and m_2 such that:

$$\nu_\mu = \cos\theta\ \nu_1 + \sin\theta\ \nu_2$$
$$\nu_e = -\sin\theta\ \nu_1 + \cos\theta\ \nu_2$$

Show that if one starts with a pure ν_μ weak eigenstate at t=0, then after the state propagates over some distance, L, the probability of the state being a ν_e weak eigenstate is:

$$P(\nu_\mu \rightarrow \nu_e) = \sin^2 2\theta\ \sin^2(1.27\ \Delta m^2\ L/E)$$

where $\Delta m^2 = m_2^2 - m_1^2$, L is the distance in meters, and E is the neutrino energy in MeV.

(2) In a simple parton model of the proton, the various quark momentum distributions are given by :

$$x\,u(x) = 12.0\ (1-x)^5 + 0.2\ (1-x)^7$$
$$x\,d(x) = 6.0\ (1-x)^5 + 0.2\ (1-x)^7$$
$$x\bar{u}(x) = x\bar{d}(x) = 0.2(1-x)^7$$

a) Show that these distributions are consistent with having two u and one d valence quark in the proton.

b) From these distributions calculate the total cross section for neutrino and antineutrino scattering on a nucleus with equal number of neutrons and protons. (Such a nucleus is said to be an “isoscaler” nucleus.)

c) What is the value of the F_2 structure function at x = .1 for neutrino and electron scattering on an isoscaler nucleus using the above distributions?