1) Estimate of (m_d-m_u) mass difference from the masses of Σ^+, Σ^-, Σ°. The three sigma baryons have the following masses and quark contents:

Σ^+ (1189.37) = uus, Σ^o (1192.64) = uds, Σ^- (1197.45) = dds

Assume that these differences are due to differences in quark massen and to differences in electromagnetic interactions between pairs of quarks. Assume that the latter (Coulomb interactions and interactions between magnetic moments) are proportional to the charges and that the average quark-quark separation is the same. Show that

$$M(\Sigma^-) = M_o + m_s + 2\, m_d + \delta/3,$$

$$M(\Sigma^o) = M_o + m_s + m_d + m_u - \delta/3$$

$$M(\Sigma^+) = M_o + m_s + 2\, m_u$$

M_o is the contribution to the Σ masses arising from the strong interactions between the quarks (flavor independent). Show that

$$m_d - m_u = \frac{1}{3}\,[M(\Sigma^-) + M(\Sigma^o) - 2\,M\,(\Sigma^+)] \backsimeq 3.8\,MeV/c^2$$

2) Use the above model to estimate the electromagnetic contribution δ:

$$\delta = M(\Sigma^+) + M\,(\Sigma^-) - 2\,M\,(\Sigma^o)$$

Putting in the numbers and neglecting the magnetic moment interaction, estimate the mean interquark distance. Does your answer make sense?

3) Left-overs from Problem session 5.