Elementary Particle Physics: Assignment # 10
Due Thursday April 18th

(1) 1.a) Knowing that $\alpha_s(M_Z^2) = 0.1180$ ($M_Z = 91$ GeV)obtain the value of α_s at $(2\text{ GeV})^2$ (use $N_f = 3$) and at $(100\text{ GeV})^2$ (use $N_f = 5$) and give their ratio. Compare with the ratio of the electromagnetic coupling constant α at those two energies

1.b) What value of Λ_{QCD} would give this value of $\alpha_S(M_Z^2)$ for $N_f = 5$?.

1.c) How can you explain that according to the PDB the corresponding extracted value for $N_f = 5$ is $\Lambda \simeq 215$ MeV
(see https://pdg.lbl.gov/2018/reviews/rpp2018-rev-qcd.pdf)?

(2) 2.a) Draw the Feyman diagram and write the amplitude for the QCD contribution to $u\overline{u} \to d\overline{d}$.

2.b) Obtain the colour factor for this amplitude in the colour singlet configuration. Reason the answer.

(3) Using the $SU(3)$ flavour model obtain the prediction for the mass of all the particles in the baryon decouplet and compare to data. (Hint: the quark constituent masses for baryons are not exactly the same than for mesons, see for example the table in the chapter of bounds states in Griffits)