Quantum Chromodynamics

Question 1:

Calculate the R ratio below the strange quark mass threshold and above the bottom quark threshold. Check your latter answer against the data in the notes.

Question 2:

The SU(3) gauge group generators satisfy an algebra under commutation

$$[T^a, T^b] = f_{abc} T^c$$

Compute the numbers f_{abc}.

Question 3:(involved)

The gauge group SU(2) has 3 generators

$$\frac{1}{2}\begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix}, \qquad \frac{1}{2}\begin{pmatrix} 0 & -i \\ i & 0 \end{pmatrix}, \qquad \frac{1}{2}\begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix}$$

Show that in and SU(2) version of QCD there is a singlet in the product 2×2.

Show that SU(2) gluon exchange is attractive for the singlet state.

Question 4:

Calculate Λ_{QCD} using the β function expression and the measured value of $\alpha_s(M_Z)$ in the notes and explicitly varying the number of quark flavours as you pass through each mass threshold.