M. Course work 7

This CW is optional.

Q1.

Show that the equation

$$\frac{d^2\delta}{dR^2} + \frac{3}{2R}\frac{d\delta}{dR} - \frac{3}{2R^2}\delta = 0 \tag{M.1}$$

presented in lectures can be rewritten as

$$\ddot{\delta} + (4/3t)\dot{\delta} - (2/3t^2)\delta = 0. \tag{M.2}$$

Q2.

Solve (M.2) using the trial solution $\delta \propto t^m$ to obtain the two modes of perturbations.

Q3.

Given that the amplitude of the density perturbation at the moment of decoupling, $t \approx 3 \times 10^6$years, is about 10^{-5} and that the nonlinear stage in the evolution of this perturbation started at the moment $t \approx 3 \times 10^9$years, estimate the two arbitrary constants in your solution for the density perturbations.

Q4. Explain qualitatively why gravitational instability only starts to work after decoupling and why the anisotropy of the microwave background yields information about the physical conditions in the universe at the moment of decoupling.