Mid Exam : Topics in Cosmology

1. Plot the following.

   (a) Using the CAMB code, plot the linear density power spectrum, $P_\delta(k)$, for a flat Planck cosmology with initial conditions ($h = 0.677$, $\Omega_m = 0.31$, $\Omega_\Lambda = 0.69$, $\Omega_b = 0.048$, $n_s = 0.96$, and $\sigma_8 = 0.8228$). (10 pt.)

   (b) Plot the linear density variance, $\sigma_\delta^2(M)$, as a function of mass M in the range of $1 \leq M/(10^{12}\, h^{-1}\, M_\odot) \leq 10^3$ for three different cases of the window filter at $z = 0$. (10 pt.)

   (c) Plot the Press-Schechter mass function with normalization factor of 2, $dN/d\ln M$ vs. $\log M/M_\odot$ at $z = 0$. (10 pt.)

   (d) Plot the Sheth-Tormen mass function at $z = 0$. (10 pt.)

   (e) Plot the Jenkin et al. mass function at $z = 0$. (10 pt.)

2. Look for a reference that describes a new halo-finding algorithm dubbed the *Rockstar*. Write a short (one page long, 12 pt.) summary of this algorithm, describing its difference from the conventional algorithms like the FoF and SO halo finders, its advantages over the conventional ones, and downsides as well, if any. (20 pt.)

3. Analyzing the FoF halo catalog from the MDPL2 simulation[1], numerically determine $dN/d\ln M$ and compare them with the above three analytic mass functions. Repeat the same calculation but with the Rockstar halo catalog. (30 pt.)

[1] https://www.cosmosim.org/cms/simulations/mdpl2/