1) a) Sketch the behavior of the coefficient of first normal stress difference, viscosity and the recoverable shear strain as a function of rate of strain.
b) How is the recoverable shear compliance related to the recoverable shear strain?
c) How are the low shear rate behaviors of the viscosity, coefficient of first normal stress difference and recoverable shear compliance related?
d) For a Lodge liquid how are the time dependent shear stress and first normal stress difference related to the time dependent modulus for a variable rate of strain and for a constant rate of strain?
e) How are the zero shear rate viscosity and coefficient of the first normal stress difference related to the time dependent modulus?

2) a) For the dumb bell model write an expression for the velocity of one of the ends of the dumb bell relative to the other end (Langevin equation) when it is subjected to random Brownian motion.
b) Sketch the prediction of this model, position versus time.

3) a) Give an expression for the particle velocity in the Rouse model similar to that given for the dumb bell model (leave out the Brownian term).
b) Write the wave solution to this equation in 1-d for a polymer chain of infinite molecular weight.
c) Give an expression for the relaxation time for the Rouse model with a chain of infinite molecular weight.